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Electricity systems,"market liberalization" reforms, governance systems,internationalization, and the need for new democratic governance systems-the Danish case

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Electricity Reforms, Democracy and Technological Change

(*Electricity systems, "market liberalization" reforms, internationalisation, and the need for new democratic governance systems - the Danish case)*

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Preface

This book is one of three books from the research project, *"Internationalisation of the energy markets, and its influence on the Danish energy policy, with special focus on the Danish-German connection"*.

The project was financed by the Ministry of Environment and Energy within the program for *Energy and Society, and Aalborg University*.

This book *"Electricity Reforms, Democracy and Technological Change"* deals with a description of the dynamics of the Danish energy system and its public regulation processes, with special focus on the electricity sector.

Another book "Current corporate strategies of the German Electricity Supply Industry" written by Lutz Mez and Annette Piening, Freie Universität, Berlin, deals with the development within the German energy sectors, focusing on public regulation processes and the electricity sector.

In the third book, *"Renewable Energy Governance Systems"*, I compare the new German renewable energy law with the Danish renewable energy legislation from 1999.

Without intending to escape a personal responsibility for the written English, I want to thank both Gwen Bingle (first two chapters) and Juliana Felkner (the rest of the book) for their competent and patient work with correcting and improving my English.

Finally, I would like to thank Annelle Riberholt for doing the layout work on the book.

Frede Hvelplund
June 2001

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1. Introduction

1.1 Energy policy background

The *background* for this analysis is the process of change that the energy systems all over the world, and especially in Europe, are undergoing within the following fields:

a. Mainly since the mid 1980ies, new energy policies are in the preliminary stages of being established, in order to reduce the growth in greenhouse gases and decrease dependence upon fossil fuels.
b. Since the beginning of the 1980s, the first shaky steps have been made towards a technological paradigm shift, from fossil fuel- and nuclear technologies to renewable energy- and energy conservation technologies.
c. As a consequence of these developments (a and b), an organisational and technological battle has been taking place these past years between the old nuclear and fossil fuel ”sunset” technologies/organisations and the renewable energy and energy conservation ”sunrise” technologies/organisations.
d. In the midst of this technological transition/battle, a world-wide movement promoting new public regulation regimes, often named ”liberalization” or ”privatisation”, has had substantial success in introducing and implementing these changes into the former public regulation framework. These new public regulation regimes are usually justified by classical arguments saying that increased competition will increase cost efficiency, and result in decreased energy prices. The rationale behind these reforms is not, has never been, and cannot really be linked to environmental goals.
e. The typical ”liberalization” version is being linked to the privatisation of ownership, consumer access to buy electricity from various suppliers, the introduction of tradable greenhouse gas permits and in some countries, like Denmark for instance, and the introduction of quotas for renewable energy, combined with a market for ”Green Certificates”.

Until the 1999 electricity reform in Denmark, technological innovation in certain fields met with considerable success. The use of cogeneration, renewable energy- and energy conservation technologies proliferated, resulting in an absence of increase in CO2 emissions since 1975, and that, despite a GNP rising by 70% during the same period of time. The last decade has brought extensive introduction of cogeneration and wind power, where co-

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generation now accounts for around 50% of the heat consumption and wind power for more than 15% of electricity consumption. The export of energy technologies has been booming with a growth of 500% between 1992 and 2000, where it reached 20 billion Danish crowns.

The Danish energy system has so far been characterised by a high proportion of municipal and consumer ownership. The electricity system has succeeded in supplying electricity at the lowest prices in EU Europe, and at prices which, for many consumer groups, have been only 35-40% of, for instance, the German electricity prices. At the same time, Denmark has had the most egalitarian electricity price structure in EU Europe, with small industrial consumers and farmers paying almost the same kWh price as large industrial consumers. The Danish system has been financially consolidated with almost no debt within the electricity system, but also without any free financial funds[1]. The German electricity system is a shareholder owned system, which has had, and still have, considerable political power, and very high electricity prices. Furthermore, the German electricity system has been allowed untaxed accumulation of huge funds for the decommissioning of nuclear plants.

At the end of the 1990s, Danish energy policy reached a turning point because of technical challenges due to the high proportion of fluctuating wind power production and the increased cogeneration share, and because of new regulation regimes being introduced in Denmark and its neighbouring countries. In this specific historical situation, with the above background, the questions that will be analysed in this publication are as follows:

1.Which governance systems[2] are most efficient, with regard to achieving optimal goal performance by means of the present typical uranium/fossil fuel electricity supply systems?

2. Which governance systems are the most efficient in the transformation process from the present uranium/fossil fuel electricity supply systems to renewable energy-/conservation based electricity system?

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[1] The Danish electricity system has a debt amounting to around 10-15% of the total value of its fixed assets. At the same time the law has not allowed any accumulation of free financial liquidity.

[2] "Governance systems" is a relatively broad concept which here includes public as well as private regulation at the "first order" as well as "second order" level. See figure 5.

3. Which changes in goal performance of the Danish electricity supply system has the 1999 Danish electricity "liberalization" reform induced?

4. Will the Danish electricity supply system be able to maintain its consumer ownership institutions and remain independent of the "third party" shareholder ownership structure after the 1999 Danish "liberalization" reform?

a. Are the Danish electricity companies able to compete on the Danish electricity market with foreign suppliers?
b. Will the Danish energy companies be able to compete on the market for energy capital goods, or will foreign companies, for instance German power companies, buy them? Will the Danish consumer ownership model survive?
c. Will the Danish ”flat” price structure survive on the future electricity market?
d. Will the 1975-2000 energy technology innovation process survive under the new market conditions? How will conditions on the German market influence this development?

The relevance of these questions is particulary enhanced when seen in relation to the goals of international, and especially Danish, energy policy. The main question therefore, is: will the development outlined under 1,2,3 and 4a, 4b, 4c and 4d strengthen or weaken the possibilities of achieving the Danish energy policy goals**?**

1.2 The interrelationships between Danish and North European **second order**[3] *energy systems*

When analysing what happens to the Danish energy system, once it is confronted with the external influences from Northern European and especially the German energy systems, it is necessary to see this situation in relation to the goals of Danish energy policy.

Furthermore, it is important to realise that the energy systems in industrialised countries such as the Scandinavian countries and Germany are confronted with a stagnating energy market. Consequently, energy companies are seeking markets for know-how and power plant technology outside these areas, in Eastern Europe and in developing or transition countries, such as China, for instance. This is indicated here by the big arrow on top of Figure

[3] The "Second order Governance system" is here defined as the governance system, which governs a sector of the economy. See comment linked to Figure 5. Page 28.

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1 pointing at boxes (4), (8) and (9). It is worth keeping in mind that these markets represent a very important technological “battlefield”, where the main direction of technological innovation is designed and decided upon. This area of analysis is not the main focus area in this publication, but it is worth being aware of the fact that the “technology battle” might be won or lost outside our main focus area.

It is obvious that when wanting to analyse the interrelationship between Danish and German energy systems, one needs to have a macro-structure describing the energy systems within these two countries. It is also reasonable to expect that the analytic macrostructure should contain a description of the public regulation mechanisms within Germany and Denmark, as well as EU influences. Due to the impact of the Scandinavian energy systems on the Danish and North European energy systems, one cannot omit including a description of the Scandinavian energy systems as an important element of the macro-structure.

1.2.1 The channels of influence

The influence that we analyse is a function of both the **”sender system”** in the rest of Scandinavia, Germany and EU, **”the receiver system”** in Denmark, and the effects of technology export to Eastern Europe and developing countries.

The messages from one focal “sender”, such as Germany, are:

a. Market power development resulting from potential electricity sales from Germany to Denmark and from Denmark to Germany, including here “transit” movements of electricity between Germany and Scandinavia.
b. Power and ability to buy electricity systems. Here also including discussions of alliances and fusions between German and Scandinavian electricity companies.
c. Power related to innovation influence, linked to the general energy policy in Germany, which influences the Danish export and import of new technologies.
d. The direct relationship between German and Danish public regulation processes and their outcomes.
e. The expansion of German companies to Eastern Europe and developing countries and its influence on the direction of technological innovation.

By “Germany” is meant mainly the German fuel-, power-, transmission- and distribution companies, and their interrelationships with political and public regulation processes.

We want to examine how the above factors, a-e, might influence the Danish electricity system and the Danish energy policy as a whole, especially the development of cogeneration, technological innovation within renewable energy and conservation, the price level and price structure, etc.

We are naturally aware that the ”message” goes both ways, but in these analyses we mainly focus on Denmark as the **”receiver system”.**

From these analyses, it should then be possible to analyse the influence of the interactions between boxes (2), (6), (10), (3), and (1), and how these in turn act upon the goals of Danish energy policy.

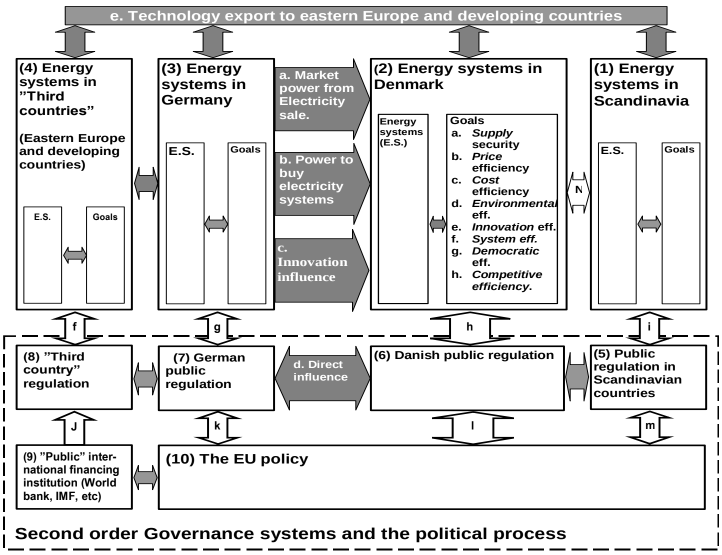

Figure 1. Analytical macro-structure of second order energy systems

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Figure explanation*:*
The ***above macro-structure*** *deals with second order sector energy systems and includes:*

a. *The relationship between four "country" categories, namely Denmark, the other Scandinavian countries, third countries and Germany, boxes 1, 2, 3 and 4.*
b. *The relationship between goals and energy systems in each "country category".*
c. *The governmental public regulation level, boxes 5, 6, 7, and 8.*
d. *The EU and "international" organisational level, boxes 9 and 10.*

The ***channels of influence*** *are supposed to be:*
market power from electricity sale,

e. *power to buy other electricity systems,*
f. *innovation influence,*
g. *direct public regulation interdependence and*
h. *innovation influence through " third countries".*

Basing oneself on the above, the macro-structure described further on in Figure 6, and on the channels of influence described here, it is then possible to combine the knowledge about the influence from the EU as well as the Scandinavian and German systems with the knowledge concerning the dynamics built into both the Danish and the German energy systems.

This combination requires the development of a theory regarding the structure and dynamics of the microstructures within the Danish and German energy systems, and their interrelationships with the political process and the public regulation process in both Denmark and Germany.

This book mainly deals with the development of an adequate description of the Danish energy system, Figure 1, boxes (2), (6) and (10).

Another book made by Lutz Mez and Annette Pienning, 2001[4] deals with the development of the German energy system, Figure 1, boxes (3),(7) and (10).

Finally, the book "Renewable Energy Governance Systems" (Hvelplund, 2001), deals with the interrelationship between German and Danish public regulation (boxes (7) and (6) and the arrow d.

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[4] Mez,L, Piening,Annette, (2001) "Current corporate strategies of the German Electricity Supply Industry." Freie Universität, Berlin.

2. The theoretical approach: Goals, “organisation of action” and adequate analytical levels of aggregation

“What enables man to know anything at all about the World around him?” Knowing demands the organ fitted to the object”, said Plotinus (d. AD 270). Nothing can be known without there being an appropriate “instrument” in the makeup of the knower. This is the Great Truth of adequatio (adequateness), which defines knowledge as adaequatio rei et intellectus: the understanding of the knower must be adequate to the thing to be known.” (Schumacher, 1977).

The above quotation has inspired this chapter in the sense that it underlines the need to establish adequateness in the “knower” regarding the areas and questions to be analysed. The “knower” here is the analyst together with the theory and structure of reality being established in order to perform the analysis, in other words, the process to reach a better understanding. The approach is thus inspired by the concept of adequateness, but it should be emphasised that it aims at being far more “concrete” and action oriented than the above quote seems to imply. To clarify this, it should be mentioned that Schumacher further on dissociates himself from the scientific reductionism of Descartes and calls the subsequent scientific tradition a “science for manipulation” as opposed to a “science for knowledge and enlightenment”, which he advocates (Schumacher, 1977, p.65). The approach here within the second order governance evaluation does not partake of either category. What is characteristic of the present perspective is a constant endeavour to establish “knowledge and enlightenment” in order to establish a non-reductionistic knowledge base for conscious decisions. But it could also be described as a “science for open ‘manipulation’” by a knowledgeable public. Before engaging with the specific analysis, we will elaborate on the theoretical and methodological considerations guiding the analysis by means of a simple ***“bicycle tour example”.***

2.1 The “adequate” macro-structure

A person (a) wants to get to a village, Sønder Tranders, in time and in good health (b) from another village, Visse (c), riding a bicycle (d) on a road (e), without hurting or getting hurt by other road-users (f) or suffering from the cold or rainy weather (g).

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First of all, we find it important to point out, that a set of governing policies has constructed the basic elements underlying these particular circumstances. These basic conditions are the existence of bicycles, roads, cars on the road, and the need to go from Visse to Sønder Tranders, etc. Here, the system that has established this "structure" is called the first order governance system with its first order macro-structure. This first order macro-structure represents the societally constructed institutional structure and governance systems (see Figure 1). The person wanting to go from Visse to Sønder Tranders cannot change these conditions in the specific "tour" decision process. They can only be changed through political processes influencing the structure and basic conditions in society on a longer-term basis.

Here we will focus on the resulting second order system and the following important characteristics of the situation. We have:

1. A person (a)
2. A goal hierarchy established by the person (b)
3. A starting point (c)
4. A transport medium (d)
5. A road (e)
6. Other road-users (f)
7. The weather conditions (g)

In order to make a successful trip, and reach Sønder Tranders in time and in good shape and health, the person (a) must have a general perception of the relevant macro-structure. The above 1-7 categories can be said to form a rather relevant perception of the macro-structure. It is crucial to be aware of one's abilities, the destination, the starting point, which transport medium to use, the surface one is riding on, and which other types of road users could be encountered during the trip, as well as the weather conditions. Naturally one could add other elements to the macro-structure, or describe other macro-structures, such as *possible occurrence of dangerous animals, eager but untrained hunters, etc. etc.,* but the above seven categories might be seen as a rather reasonable second-order macro-structure linked to the trip. The existence of other potential macro-structures is symbolised in Figure 1 by the dotted 'shadow' boxes in the background.

Nevertheless, nobody would find it unreasonable to want to have knowledge regarding one's own abilities, the goal of the trip, the transport medium, the road, other road users or weather conditions. Lack of knowledge regarding any of these categories might entail deadly danger.

The above first and second order macro-structures are illustrated in Figure 2.

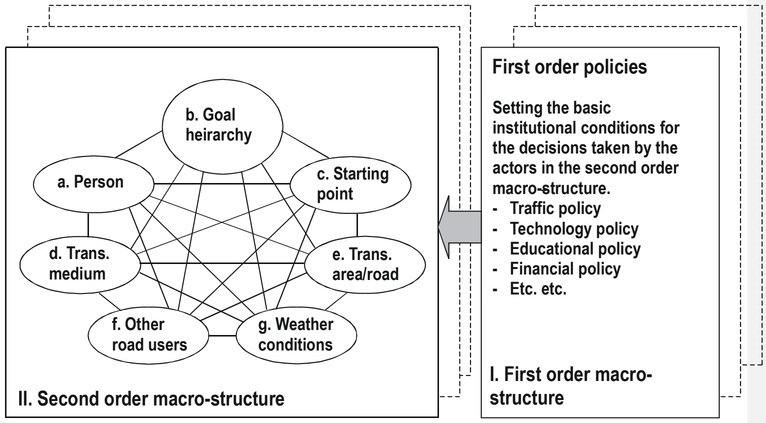

Figure 2. The bicycle tour and the adequate analytical macro-structures

***Figure comments**: It is worth noting that we have not yet established any theory regarding the relationships between the 7 components of the macro-structure (the character and contents of the lines). Neither have we established any theory regarding the internal dynamics of each of the 7 components of the macro-structure. The stippled boxes in the background indicate that there are other macro-structures that could also be described. One might claim that the number of possible macro-structures is infinite, and that the interrelationships between these macro-structures are also limitless. The one chosen here is not incidental, but governed by the combination of a specified goal hierarchy and a particular action organisation.*

It important to state that there is an infinite number of potential macro-structures, and that the ones selected are chosen by means of the specification of a spectre of goal hierarchies as well as a spectre of possible action organisations. If we had no goal hierarchy, it would be senseless to demand the description of the transport medium, other road users, weather conditions, etc. What lends meaning to the inclusion of these components is the existence of a goal hierarchy and an "action organisation": in this case, the person. When this "action organisation" and its goal hierarchy is included in the system description, there is a spectrum of feasible descriptions and theories and there are other descriptions and theories which are not feasible, seen in relation to the goal hierarchy and the abilities of the "action organisation". Here it is considered a basic and very important observation, and from it, we also derive/assert that any system description and system theory has a de-

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clared (conscious) or undeclared (unconscious) in-built goal hierarchy and action organisation.

2.2 An "adequate" analytical micro- structure

When wanting to obtain useful action advice, having knowledge about potentially adequate macro-structures is not sufficient. One also should have detailed knowledge concerning the characteristics and dynamics of the microstructure within each component of this macro-structure. Furthermore, one should try to establish a useful model of the dynamics within the macro-structure, which is a function of the combined dynamics of seven different components of the macro-structure, in this case.

Concretely, the cyclist needs to know something about the other road-users, such as their speed and varying competencies when it comes to watching out for other cyclists, their ability to brake, etc. S/he need not be aware, however, of how cars and wheels are manufactured, or how a petrol engine functions. So, as far as other road-users are concerned, adequate knowledge is that which is relevant to the aims of the trip, especially the goal of reaching Sønder Tranders in good health. S/he should also know something about the road, such as how broad and how slippery its surface is, perhaps also how these parameters interact with meteorological conditions (e.g. rain or frost), which could make the road icy. There again, knowledge about the specific plants growing in the ditch, the way asphalt roads are made or their price, is hardly relevant to reach the intended destination, whereas the knowledge and theory about roads outlined higher, is more adequate for this specific situation and these goals. As to the bicycle, how to use the pedals and the brakes, keeping one's balance and steering safely, are certainly prerequisites. Needless to say, information about how the bicycle frame, the tires and the wheels have been produced or about the molecular structure of steel and rubber is beside the point here. There is, nevertheless, an appropriate type of knowledge linked to the "action" of using a bicycle under these specific conditions combined with the particular cyclist's existing potential (his/her strength, eyesight, hearing and ability to react, etc.).

When elaborating a useful microstructure and theory linked to this microstructure, it is important to consider the purpose/goals of the macro-structure and the "action organisation" of the latter. In Figure 3, the establishment of a microstructure within each of the components in the macro-structure is illustrated by the squiggly pattern within each of the a-g ellipses.

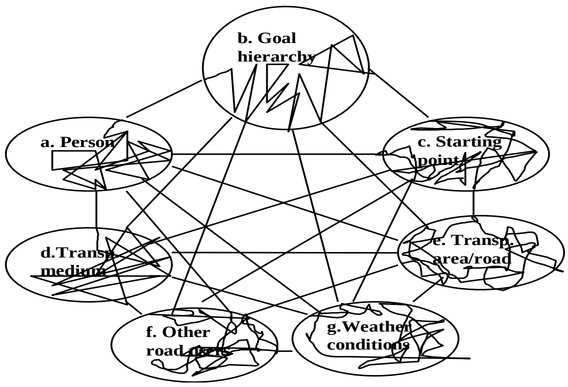

Figure 3. The adequate microstructures within the adequate second order macro-structure

Figure comments*: The figure illustrates that there is a "road", "weather", a "starting point", a "person/organisation", "other road users", a "bicycle", and a "goal hierarchy" microstructure. This microstructure is illustrated by the squiggly pattern within each component of the macro-structure. This microstructure combined with the theory that outlines relevant micro-dynamics, is linked to the macro-structure through the interrelationships within this macro-structure. Systematic thoughts (theories) have to be developed regarding the dynamics of these microstructures and their connections to the other components of the macro-structure. This results in theoretical fragments outlining parts of the dynamics within the macro-structure. Clearly, it will never be possible to develop a dynamic model of the macro-structure without huge inherent elements of uncertainty, both with regard to the feasibility of the model and with regard to the difficulties of accessing the necessary information for the implementation of the model.*

What this example illustrates is that there is an adequately relevant "area" regarding the level of aggregation in the description, once the goal hierarchy and the "action organisation" have been defined. Once the purposes of a trip have been decided upon, and the organisational and technical means have been secured, the appropriate levels of description and spectres of relevant theories are then framed within a certain area. Without knowing why one should describe the above macro-structure, but only knowing that one should provide descriptions regarding roads, other road-users, the weather, bicycles

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and persons, etc., one would be unable to either select an “adequate” theory or an “adequate” description.

Likewise, one can state that any aggregation level-, and type of description linked to any theory regarding the dynamics of a system, has a conscious/overt or unconscious/hidden spectre of action linked to covert[5] and not necessarily even existing potential agents of action.

So there is no one DESCRIPTION or one THEORY, but only theories that are only relevant when seen in relation to a hierarchy of goals and a specific set- and type of action organisations (actors).

Furthermore, it should be underlined that anybody can construct new system descriptions and new theories about everything, as the spectrum of possible descriptions and theories is infinite. The real “scientific challenge”, therefore, is to develop theories and descriptions that are relevant to certain goal hierarchies and organisations of action, and to describe the character of this adequateness thoroughly for the reader.

In parallel, it should also be pointed out that this by no means suggests that the descriptions and theories should be linked to existing goal hierarchies and existing organisations of action. Particularly during periods when technical and organisational changes are needed, these descriptions and theories should be linked to totally new or marginally powerful organisations.

Furthermore, it is worth pointing out that it is the apprehension here that there are no other possibilities than to link theories and description with goal hierarchies and organisations of action, since any consciously/open or unconsciously/covert theory and description is, by logical necessity, linked to a specific spectre of goal hierarchies and organisations of action.

The scientific “democratic obligation”, therefore, is to also elaborate the above descriptions and theories in such a way that it is possible for the reader to uncover the spectrum of action organisations and goal hierarchies linked to given theories and analytical levels of aggregation.

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[5] Combining the expressions ”covert” and ”not existing” might sound contradictory, but just indicates that ”covert” can also mean ”not entering the societal agenda at all”, which is in fact the most efficient conscious or unconscious way of hiding any- and hindering the arrival of a potential future organisational competitor on the societal scene.

It is worthwhile to observe that by establishing the scientific procedures needed for the implementation of this “democratic obligation”, the hitherto occult organisational and goal conservatism built into many existing descriptive methods and theories will be exposed.

2.3 Analytical adequateness and the time dimension

The time dimension is not directly illustrated in Figures 1 and 2, but is, as it will be illustrated here, crucially important for the selection of adequate theories and the contents and levels of aggregation in the description of macro-structures.

With a very short time horizon, there is a tendency to develop extremely static analyses and suggestions for action. In the bicycle example, the decision framed within a very limited time horizon will, for instance, only deal with short term “action questions” such as, “it is raining, I should wear a rain coat”, “it is icy, I should be cautious and wear a bicycle helmet”, “it is windy, I should start five minutes earlier”, “it is dark, I should take the bicycle light”, etc.

With a longer time horizon, a few months for instance, the decision will also include considerations regarding the potential acquisition of other transport mediums, such as a moped, roller skates, a car, etc.

As we extend the time horizon even further, the next question to arise could be whether to continue working in Sønder Tranders, or to work somewhere else.

The above examples just illustrate the link between various types of actions and the time horizon considered, in other words, the link between the time horizon and adequate first and second order macro-structure(s). Thus, if the time horizon is extended, and the decision process includes the potential acquisition of a car, a totally different second order macro-structure should be elaborated on.

When establishing the adequate analytical macro-structure, it consequently is necessary to lay down an approximate time horizon. If this is not done, individuals and societies risk getting trapped by their “short term” projection, without being able to establish strategies for long term change.

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2.4 The action dimension and analytical adequateness

Giddens (1979) deals with "Action, Structure and Contradictions in Social Analysis". One of his conclusions, based upon his critical literature study of the work of other sociologists, is the one shown in Figure 4.

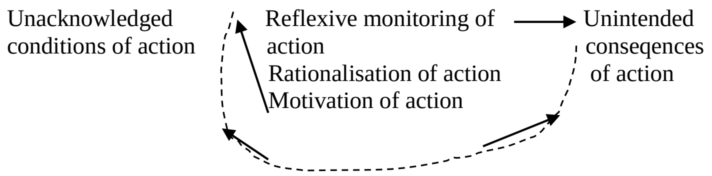

Figure 4. Conditions and consequences of action
Source: Giddens (1979), page 56.

In this figure, Giddens purports that we know neither all the preconditions of action, nor all the consequences of our actions. Therefore, history is, though guided by reflexive actions, not an ongoing rationalisation process. Few analysts would contest this conclusion. Nevertheless, he does not deal with analysing the conditions and processes determining *the amount- and character* of "unacknowledged conditions of action" and of "unintended consequences of action". Logically, the *character and amount* of unacknowledged conditions and unintended consequences are also, according to Giddens above, a function of the strength and type of reflexive monitoring, rationalisation, and motivation for action. Thus, the amount- and character of unacknowledged conditions and unintended consequences will vary according to whether the reflections, rationalisations and motivations are analysed by sociologists, like Giddens, or by other types of sociologists focusing more on the structural bindings in society, such as sociologists and industrial economists empirically examining the "action processes" in society, or by neo-classical economists who hardly analyse the impacts of institutions upon the economic processes.

Giddens' study in this book is characterised by an absence of empirical studies, and by being mainly developed on the basis of critical studies of the work of other sociologists. This naturally results in conclusions such as those to be found in Figure 4, where there is no information about the impact on history and the direction of development, as a function of the character of the reflexive processes, etc., being influenced by the actor. Also it shows where there is, as a consequence of the "literature analysis" method used in the book, a theoretical discussion of "Action, Structure and Contradiction in Social Analysis", but no concrete development or description of potential actions in various concrete situations.

Our opinion here is that there is a need to develop theories of action based upon concrete studies of concrete events and linked to the analysis of existing and potential future organisations in society, mainly because such studies might increase the amount of qualified "reflexive actions" made available for public reflexive decision processes. This opinion is based upon experience from Danish energy policy since 1976, where the concrete analysis of technical and organisational alternatives has been one of the important catalysts of change. Seen in relation to Figure 4 above, this type of analytical practise decreases the amount of unacknowledged conditions and unintended consequences of publicly open and well-informed reflexive decision processes.

Therefore, the intention in this study is to establish an analytical adequateness, which makes it possible to decrease the amount of unacknowledged conditions of action and unintended consequences of action. Hence, it is a must to begin with empirical studies of change processes.

Another interesting aspect, when dealing with an analytical level of aggregation where concrete action potentials are developed, is that the character of the *unacknowledged conditions of action and the unintended consequences of action* might be described as various categories of uncertainty, against which it is possible to take some action precautions. Clearly, when cycling from Visse to Sønder Tranders on any given day, there are a lot of unacknowledged conditions of action. The road might be unforeseeably icy. If we analyse the situation concretely, our precaution against this type of "unacknowledged condition" might be a bicycle helmet. There might be nails on the road, potentially leading to a puncture. Here the precaution might be to always carry a tire repair kit, etc. An unintentional consequence could, for instance, be to hit other road users. Being aware of this unintentional dimension means that one can take preventive measures such as, for example, a good lamp, efficient brakes and careful riding.

Hence the combination of:

a. Concrete empirical analysis combined with a demand for the description of concrete actions might decrease the amount of unacknowledged conditions for- and unintended consequences of action.
b. The integration of "reflexive monitoring of action and rationalisation of action" with the "design of action" might represent a further reduction of

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the negative consequences of the above "unacknowledged and unintended" features.

2.5 Action and descriptive/theoretical adequacy, a methodological summary

When wanting to analyse the influence of the German Energy Scene trajectory on the development of Danish Energy Policy, the following recommendations may therefore prove effective:

1. Outline the goal hierarchy and relevant organisations of action.
2. Define the relevant time horizons.
3. Develop the adequate first and second order macro-structure linked to the problem, taking into account the above goal hierarchy, organisations of action and time horizon.
4. Analyse and find the adequate microstructures and accompanying theories for each of the components in the macrostructure.
5. Analyse and develop an adequate theory linked both to the macro-structure and to the organisation of action. *This is the first type of basic knowledge used for the construction of action alternatives.*
6. Analyse and describe the character and amount of unacknowledged conditions for action and unintended consequences of action. Describe the elements of analytical uncertainty. *This is the second type of basic knowledge used for the construction of action alternatives.*
7. Design a spectre of action alternatives on the basis of relatively certain and relatively uncertain knowledge. *It should be underlined that this is the main result of the analysis, the main purpose of which is to develop an increased array of carefully elaborated action possibilities for the public (the action organisation).*

With regard to the character of the analysis, the following should be emphasised: a. It should be underlined that almost anybody can construct new system descriptions and new theories about everything, as the spectrum of possible descriptions and theories are infinite.

The real "scientific challenge", however, is to develop theories and descriptions that are adequate to certain goal hierarchies and organisations of action, and to be conscious regarding the character of this adequateness.

b. It is important to state that it is the understanding here that there are no other possibilities than linking theories and description with goal hierarchies and organisations of action, as any theory and any description consciously/open or unconsciously/covert by logical necessity is linked to a specific spectrum of goal hierarchies and organisations of action.

The scientific "democratic obligation", therefore, is to describe the above descriptions and theories in such a way that it is made possible for the reader to uncover the spectrum of action organisations and goal hierarchies linked to given theories and analytical levels of aggregation.

In the present analysis we will be inspired by the above eight main points regarding *"action and descriptive theoretical adequacy".* In this process we are dealing with the electricity system as the "point of departure" energy system, but we are always perceiving this system as an integrated part of a larger energy system, comprising, for instance, heat as well as transportation.

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3. The electricity system and its societal context

3.1 Goal hierarchy

What happens within the Danish electricity supply service system, when it is confronted with liberalization reforms and interactions with the neighbouring electricity systems, has to be evaluated against a set of energy policy goals, which can be listed as follows, as far as the Danish case is concerned.

The general goals of Danish energy policy are to decrease the CO2 emission within the 1988-2005 period, whilst at the same time increasing the share of renewable energy to 12-14% of the total energy supply. It also is a general goal to maintain openness of information and to both use and encourage democratic participation in the development and implementation of the above energy policy. Within the electricity sector, these general goals can, according to our understanding here, be made operational by dividing them into in the following sub-goals:

a. Ensuring *supply security*, viewed within a world-wide perspective, and more lately a New Zealand and California deregulation perspective, is by no means a natural reflex or automatism.

b. *Cost- and price efficiency*
We find it very important to distinguish between cost and price efficiency, as one can easily end up in a situation with high cost efficiency and low price efficiency, due to the establishment of monopolistic and/or oligopolistic markets.

c. *Environmental and innovation efficiency*

d. *System efficiency*
This goal deals with the discussion of how wind turbines, cogeneration plants, large coal-fired plants, etc., fit together with the other system components in a low energy system; a problematic area, which is also usually totally absent from the deregulation discussion.

e. *Democratic efficiency*
This goal focuses on a question that is seldom asked, namely: "which organisation of the energy system is the most governable"?

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f. *Competitive efficiency*
This goal is centred around the future ability of the Danish electricity system to compete on the so-called “open" electricity market.

Taken together, when establishing the “adequate” mode of description and “adequate” theoretical tools, the above goals are important in the process of defining adequateness. And it is, amongst others, with this aim in mind that they are developed.

3.2 The organisations of action, and time horizon

The analyses here are developed as part of a public energy policy generation and planning process. This means, that the primary organisations of action are the public administration, the public media and the grassroots groups dealing with the development and implementation of new organisational and technical ideas aiming to pursue and elaborate on the general goals of the energy scene.

In principle, the time horizon has to extend far enough for it to be possible to discuss techno-organisational solutions that are profoundly different from existing solutions. By this it is meant that the discussion forum has to be able to deal seriously with radical technological changes, that is changes that not only encompass new techniques, but also include the arrival of new organisations on the energy scene. Furthermore, it should be borne in mind that, at the end of the day, these new organisations might make existing energy organisations obsolete.

The time horizon should therefore reach out from the present to 30-50 years from now. What is important here is that this choice of time scale includes *proposals for action from day one and onwards*, and should not be considered as a discussion regarding potential actions to be promoted in a distant future. Considerations linked to the long-term horizon are consequently built into the decision(s) from day one.

To conclude, one can say that the present analysis is a “public service” analysis designed to develop action possibilities to be selected by the public through open and informed democratic processes.

3.3 The electricity system and its first and second order macro-structures

The aim of this discussion is to circumscribe the societal system in which the electricity system acts. This is important, as it should not be taken for granted that problems linked to the electricity system should necessarily be solved within this system. For example, the use of electricity for electronic communication could be replaced by another socio-economic structure with increases person-to-person communication. The use of electricity for cooling and freezing purposes could be partially replaced by a production structure increasing possibilities of getting fresh food from neighbouring producers, etc. Consequently, it is important to view the electricity sector as an integrated part of a specific socio-economic development. The pollution consequences it generates, for instance, could be reduced not only by introducing more ecologically efficient electricity production equipment and/or electricity conservation measures, but also by means of more ecologically efficient and sensible production structures. It is therefore worth having some understanding of the socio-economic system that surrounds the electricity system.
Figure 5 illustrates these questions.

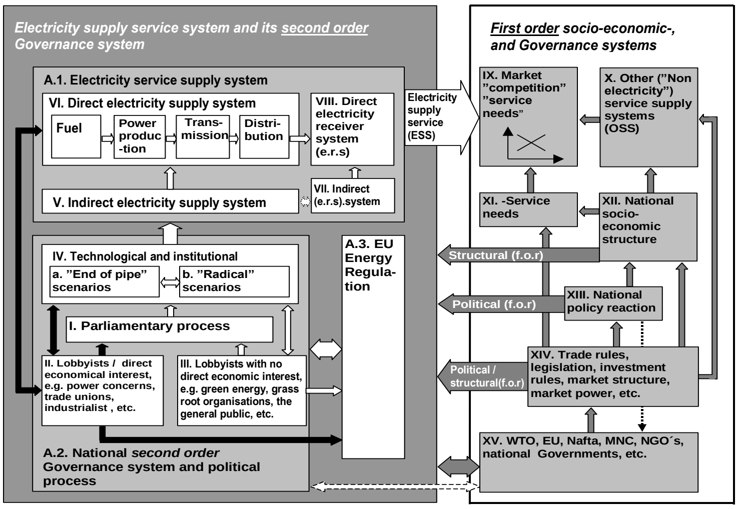

Figure 5. The electricity system and its first and second order governance systems

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Figure comments: *The figure consists of two main systems, namely the first order socio-economic and governance system, and the electricity supply service system and it second order governance system. Arrows indicate influence/impact. Black arrows represent the influence of existing fossil fuel energy companies.*

Macrostructure I (first order system): socio-economic development and political economy of the first **order** governance systems represented in grey boxes IX-XV. At this level, the structural development of society is determined by means of man-made trade rules, investment rules, etc., decided upon/influenced by the WTO, the EU, multinational corporations, national governments, NGOs, and so on.

Macrostructure II (Second order System): Electricity supply service systems and their **second order** governance systems represented by white boxes I-VIII. This system consists of the Electricity Supply Service System (ESS) boxes V,VI,VII and VIII, and its governing system, the second order national governance system, boxes I, II, III and IV.

In this paper, we will mainly deal with the second order macrostructure , but will, nevertheless, quite thoroughly describe its relationship to its "superstructure", i.e., the first order macrostructure.

We call macrostructure I the ***first order system,*** because it determines the main conditions under which the electricity system works. It determines the level and type of GNP development to which the electricity supply service system delivers its electricity-based services. It determines the costs of production factors such as fossil fuels, windmills, transportation, etc., the socio-economic structures and the needs (amount and character) for electricity supply services.

Generally speaking, there are three main areas in this first order system, where the *need* for electricity supply services and the *ways of providing for them* are determined:

a. The political construction of the *quantitative* service needs for transportation, cooling, communication, entertainment, mechanical movements in production processes, etc.

b. The political construction of the competitive relationship between electricity based fulfilment of service needs, and other non-electrical ways of providing for such needs. This competition relationship is determined on the market, box IX in Figure 5.

c. The international rules for investment, influencing the specific way electricity based service is performed and the competition between renewable energy based electricity production and fossil fuel and uranium based power supply.

It is important to view the electricity supply service system together with its superstructure, the first order governance system, which determines the needs for electricity services. It is, for instance, probable, that electricity will supply a growing proportion of transportation energy, by the increasing use of electrical cars and the production of hydrogen to fuel-cell based transportation. The need for transportation is, to an increasing degree, determined in the first order governance system, therefore the type of governance within this system will also be increasingly important for the electricity production system. The need for electronic communication devices such as mobile phones, computers, etc. and electronic entertainment devices such as TVs is, to a large extent, a function of the division of labour and the social structure in a given society. Generally speaking, lifestyles determine the level of electricity consumption, and they are mainly designed at the first order governance level. Consciousness regarding the link between the first order governance level and the electricity supply service level is more and more crucial, when the necessary 80% decrease in greenhouse gas emission is to be achieved.

3.4 The electricity service supply system and its Second Order macrostructure

One can describe the electricity supply service system and its internal and external governance structures in many ways. The system description here is designed so that the institutional dynamics within the electricity service supply system can be analysed, and the relationship between the electricity service supply system and the political system are visible, and can be contrasted with a set of goals for the electricity service supply system. Furthermore, it should be visible how the dynamics also are a function of the specific socio-technical situation of change within the energy area in these decades, and the influences from the interrelationship with the development in other countries.

Any system description has its strengths and weaknesses, not to mention overlooked aspects, but the important point here is that the description reveals both how the system is being envisioned and what perspective presides over the analysis as a process. This can then lead to a fruitful discussion re-

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garding the macro description of the system and development of the adequate levels of system aggregation in the analysis.

First of all, it should be emphasised that it is rewarding for our purpose to see the system as producing services and not electricity. We therefore are dealing with an electricity *service supply system.* Consequently, the *equipment and institutions* needed to transform electricity into means which fulfil service needs, such as cooling (refrigerators etc.), entertainment (TVs, radios, computers, etc.), communication (telephones, computers, etc.), clean clothes (washing machines etc.), are defined as a part of the electricity supply service system, here called *the electricity receiver system.* The electricity supply service system, therefore, is a system which supplies *services* such as, cooling, heating, light, clean clothes, entertainment, communication, transportation, etc. The need for these services is determined outside of this system, as we shall see below.

The macrostructure which should be scrutinised

Here we deal with the macro *system structure encompassing* the organisations and themes that are important to observe, and the relevant interrelations between actors mutually and between actors and themes (Figure 6). The macrostructure system categories are in Figure 6 below, described by Box A, the ”Electricity supply service system and its second order Governance system”, Box B, the “Goals”, Box C, the “Historical situation” and Box D,”External relations”.

The main characteristics within this macrostructure can be understood by means of the following four simple questions:
(a) “Who are we?” which is illustrated by the large box A, Electricity supply service system and its second order Governance system”.
(b) “What do we want?” which is illustrated by Box B “GOALS”.
(c) “Where are we?” which is illustrated by Box C, ”Historical situation”.
(d) “How are the others?” outside our system, which is illustrated by Box D ”External interrelations”.

Within (a), “who are we?”, or the Electricity Supply Service System and its second order governance system, we find it necessary to look at this system as a double system structure with two interrelated main subsystems: A.1. Electricity supply service system and A.2. The national second order governance system and the political process. It is the understanding here that one cannot change one of these two main components without changing the other, given that we want an achievement of a certain set of goals within the goal hierarchy in Box B.

By including (c), “Where are we?”, we underline the need for describing the concrete historical situation within which energy systems in these decades are situated. If we had been in a situation with no pollution problems, and no approaching fossil fuel scarcity, no political problems linked to fossil fuel extraction, and no problems linked to use of nuclear power, the decision base would be totally different from the present. In this hypothetical situation, it would not be necessary to develop and implement comprehensive technological changes towards the increased use of energy conservation and renewables. As there are widely recognised pollution, scarcity and political problems linked to the continued extensive use of fossil fuel and uranium, radical technological changes towards increased use of renewables and energy conservation is necessary. Naturally, new technological problems and challenges are arising out of this technological development. One example is the challenges of co-ordination and regulation linked to the high and quickly growing proportion of wind energy and cogeneration in the Danish electricity system.[6] When dealing with governmental modes of regulation and the interrelationships to the external development, it is a must to include descriptions of such historical organisational and technical challenges in the analysis.

Finally, Box D in the macrostructure symbolises the need for looking at the external interrelations, when analysing the possibilities of achieving the goals described in Box B.

[6] In the year 2000, around 15% of the electricity in Denmark came from wind power, and 30-40% from cogeneration. Furthermore, the plan is that the wind power proportion shall be increased to 20% before 2010. This gives new system challenges to absorb the fluctuating wind power in the system.

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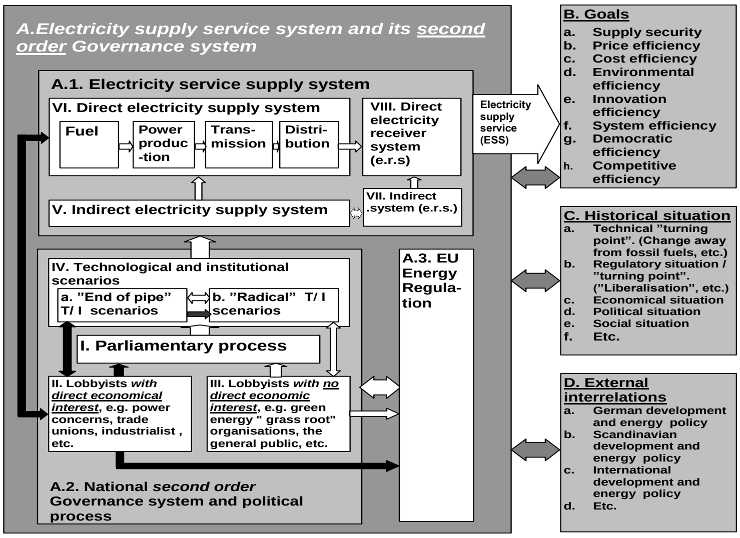

Figure 6. The electricity supply service system, and its second order governance system

Figure explanation*: This figure describes the macrostructure of the electricity supply service system by means of Boxes A, B, C and D. Box A is divided into Box A.1, the National Second Order Governance system, Box A.2, the electricity supply service system, and Box A.3 the EU energy sector regulation. Within each of the Boxes, A, B, C, and D, there are underdivisions showing the microstructure, which will be explained and analysed in the following sections and chapters regarding the difference between "end of pipe" and "radical technological changes".*[7]

[7] By radical technological changes we mean such changes that are characterised not only by the need for technical changes, but also by a demand for institutional and organisational changes. "End of pipe" technical solutions, by contrast, are characterised by being only technical changes such as, for instance, smoke abatement measures, but needing no fundamental organisational changes.

For our analytical purposes we have decided to describe Box A.1**,** the electricity supply service system, as consisting of:

- The direct electricity supply system (VI), including fuel extraction, power production, transmission and distribution.
- The indirect electricity supply system, (V), which is the production of capital equipment for the direct electricity supply system.
- The direct electricity receiver system (ERS), (VIII), meaning the equipment that receives the electricity and transforms it into energy services.
- The indirect electricity receiver system, (VII), which produces the capital for the direct electricity receiver system.

We have also chosen to describe Box A.2, the national second order governance system, and the political process, in the categories below:

As we understand the historical situation as one of extensive radical technological changes in the energy scene, we also have to establish a description of the governance system and its political processes, which takes this "radical technological change" perspective into consideration. This is concretely done by including our experiences from many studies (Lund, 1994 and Hvelplund, 1995), which are reaching the conclusion that radical technological changes require strong democratic forces which are economically independent of the established fossil fuel and uranium based energy companies. As a consequence of this well documented conclusion and the specific historic situation requiring radical technological changes, we find it adequate to establish a type of disaggregation, which distinguishes between "end of pipe" technological changes (Box IV.b.) and "radical technological changes" (Box IV.a), and between economically dependent (Box II) and economically independent lobby groups (Box III).

In Box A.3**,** the EU energy sector regulation will be analysed under A.2.'s described analytical structure.

Within the whole system, the electricity supply service system and its second order governance systems, we can divide the dynamics into the following areas.

a) The organisational *dynamics of existing energy companies.* The question here is to what extent existing energy companies are motivated- and able to break away from their existing development paths. Box II, VII, I, and V, VI, and the links between these organisations.
b) The organisational dynamics *within the existing parliamentary process.* The question here is to what extent the construction of the political pro-

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cesses has such a character that they support path breaking technological changes.

c) The dynamics *between lobbyists with direct economic interests in specific solutions (energy companies), and the political process*. The question here is to what extent the political process is motivated and able to establish a public regulation that changes the development path in the direction of sustainable energy systems.
d) The dynamics between *new energy related organisations with no direct economic interest in specific solutions and the political process.* The question here is to what extent new grassroots organisations and the general public can evolve to such strengths that they can influence the political processes.
e) The competition between "end of pipe" technological solutions such as new improved coal-fired plants, smoke abatement equipment, etc., and radical technological changes represented by renewable energy technologies, energy conservation measures, etc.
f) Dynamics of ideology production.

This a-f description should improve our ability to establish a grounded knowledge base for analysing which political action spectre is the most beneficial, when wanting to pursue the goals in Box B, under the historical conditions in Box C and with the external interrelations induced by the processes in Box D.

3.5 Aims of the electricity system

What happens within the electricity supply service system and the outcome of the interrelations of power systems in countries around Denmark, and within the Danish power system, has to be evaluated against a set of energy policy goals. In Figure 5, Box B, we have listed an array of goals, which we already shortly commented in Section 3, and on which we will elaborate a bit.

Price versus cost efficiency

We find it very important to distinguish between cost and price efficiency. The Danish electricity system has, so far, been very efficient, when looking at the combination of price and cost efficiency, since Denmark has had the lowest electricity prices for fossil and nuclear based electricity systems in the EU and in all of Europe. Germany has had the highest electricity prices in the EU and in all of Europe, but not necessarily because of especially high production costs. The main cause of the high electricity prices is the monopoly strength of the German utilities, making it possible to achieve very high profits. Moreover, it is quite certain that the UK utilities are, in many ways, as cost efficient as the Danish utilities. Nevertheless, the prices in the UK are 40-50% higher than in Denmark, due to the low price efficiency caused by an oligopoly market situation.

Environmental and innovation efficiency
During the "liberalization" debate, the discussion of environmental and innovation efficiency has played a subordinate role. The focus has been on "cost efficiency" making this equivalent to lower prices (price efficiency). In this project it is important to evaluate the influence of the interaction between Danish and German electricity systems from the perspective of environmental and innovation efficiency.

System efficiency
The discussion of how wind turbines, cogeneration plants, and large coal-fired plants interact in a low energy system is also usually absent from the regulation discussion. In the given historical situation, we find this viewpoint of the system very important because there are many new "system problems/possibilities" linked to the growth of renewable energy technologies and the spread of cogeneration plants in the whole of the energy system.

Democratic efficiency
Which organisation of the energy systems is the most governable? In Figure 1, this question is linked to the relationship between the second order Governance system, (Boxes II II IV, A.3. and I) and the electricity service supply system (Boxes V, VI, VII, and VIII). The Danish power system has, so far, been relatively governable, thanks to the non-profit consumer ownership organisation. There were no shareholders losing money when the utility companies lost markets.

Competitive efficiency
When and if the Danish electricity scene opens up for "competition" from outside electricity systems, it is worthwhile to determine whether it is able to survive within this new "competitive" context. A system might perform well, when seen in relation to all other goals, and may even be the most cost efficient producer in an area, but, at the same time, might not be able to survive the strain of competition processes in a region. The Danish system is cost efficient, but also small and without the financial reserves that could enable it to survive periods with electricity prices close to the short run marginal prices of fossil fuel (coal-fired) power plants.

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Altogether, the interaction between the Danish and the German electricity systems has to be evaluated against an array of goals. Those we think are important are the ones we have just listed above.

4. Methodological considerations

The analytical macrostructure in Figure 6 tells something about the general framework in which an analysis should be performed, namely which macro-components one should include in the analysis. Here we want to establish an analysis that is politically operational and in accordance with the demands set up in Chapter 1 and especially Section 2.5., regarding the main purpose of our study, which is to "*develop an increased spectrum of carefully prepared action possibilities for the public,(the action organisation)".*

Therefore, it is necessary to develop more disaggregated analytical categories within this macro-structure. It is also necessary to develop a microstructure within each of the components of the macrostructure, and to link these microstructures together in a theory for the whole macrostructure. Naturally, this methodology has to be regarded as an ideal, which we are trying to attain, but which we will never reach.

The above analytical macro-structure in Figure 5 might seem rather obvious, but, nevertheless, its analytical themes were not common, for instance, in the "liberalization" discourse which led up to the 1999 electricity reform. An array of reports[8] were produced for the Danish Government as a part of preparing the "liberalization" process, but this discourse gave no thorough consideration to the following themes, which are "built into" the analytical macrostructure as seen in Figure 5. These include the goal hierarchy, the potential threat from foreign acquisition of the energy infrastructure, the innovation

[8] -Report to the Kingdom of Denmark on the Valuation of the Electricity Supply Industry, Dec. 1998, N.M Rothschild &Sons Ltd. Report for the Danish Ministry of Finance.
-Konkurrence i energisektoren", Maj 1998, Konkurrencestyrelsen og Erhvervsministeriet.
-"Finansredegørelse 1997", Finansministeriet.
-"Dansk Økonomi, efterår 1997. Det Økonomiske Råd, Formandsskabet. Here it is covered broadly, but there is no detailed discussion of the goals and objectives with regulation models.
-"Nyt lys på energisektoren", En analyse af den danske el-og varmesektors internationale konkurrenceevne. Oct. 1997. Report to the Danish Energy Agency.
-"Rapport om sammenhængen mellem regulering og organisation af distributionsselskaberne i forhold til deres varetagelse af forbrugerinteresser. Andersen Management International A/S, May 1997. Report to the Danish Energy Agency.
-"Strukturanalyse af den Jysk-Fynske kraftværkssektor". PA Consulting Group, Dec. 1995. Report to the Danish Power and Distribution Company ELSAM.

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influences between countries, and the possible establishment of monopolistic and oligopolistic power in the energy markets.

The steps in Chapters 6-11 will be, within the above analytical macro-structure, to establish more specific descriptions and theories linked to the specific parts of this macro-structure. In that way, it is the intention to bring the analysis "down" to an "adequate" aggregation level, where it becomes operational, as seen from a political action (policy) point of view. Here, it must be mentioned once more that it is a well known art to establish "interesting" macro-theories which can be used to give "peace" in our scientific minds by enabling us to "understand" events that have happened. Here, it is also the intention and ambition to seek and find fragments of an analytical level of aggregation, which enables the public and the politicians to make knowledgeable and conscious decisions before "things" have happened.

One way of finding such fragments of an adequate analytical level of aggregation is to establish empirical analysis of different types. The main methods used have been, and still are:

A. *Observant participation*

Here we have two main categories:

The first category is the participation in the discussion of a concrete decision. This could be the building of nuclear power plants, as it was in Denmark in the early eighties, or the building of a specific new coal-fired plant, etc. One typical case is our participation in the 1991-1994 debate regarding the possible building of two new power plants (400 MW each) in Jutland-Funen for five billion Danish Kroner (DKr) (Hvelplund et al, 1991) and (Hvelplund and Lund 1994).

This type of "action research" can be regarded as a special type of questionnaire, where the questionnaire is made up of the statements brought to the debate. The characteristics of this type of "questionnaire" are:

a. The discussion becomes very concrete, as a concrete project is discussed.
b. The interest groups, especially, will become very distinct, as concrete interests are for discussion.
c. If performed in a sufficiently persistent manner, the "answer" from the Government institutions in particular will be "very honest", as it represents how the Government regulates in practice, and not how they say they will regulate. The answer tells what they do, and not just what they

say they will do. In the above power plant discussion from 1991-1994, it was clearly shown that the Ministry of Energy, the Municipalities and the Regional Counties at that time were not able to follow the goals of the declared energy policy. Therefore, they were subordinated to the power company interests in combination with local and regional employment interests.

The second category is the elaboration of an array of alternative energy plans for Denmark since 1975 (Hvelplund et al, 1976), and in 1993 an alternative energy plan for the Southern part of eastern Germany (Hvelplund et al, 1993). By establishing coherent alternatives to the established energy policy in a region, a concrete debate has been established, as the alternative is concrete and draws a rather broad spectrum of interest groups into the debate. The constructed alternatives always contain technical scenarios, as well as an analysis of the necessary political reforms in order to implement the technical scenarios. The construction of coherent alternatives could be regarded as a special type of questionnaire having the following feature:

d. They establish a general strategic discussion regarding the energy policy possibilities.

The two above examination categories supplement each other, as the experience learned under the first category can be used when suggesting institutional reforms in the second category. At the same time, alternative energy plans can affirm, during category one discussions regarding concrete projects, that alternative energy scenarios are possible.

B. *Discourse analysis by reading the reports and written material leading to the decisions made (often from Ministries and public institutions, in general)*

It is often linked to the discussion being performed under a, and often can only become fruitful in combination with the discussion under (A).

C. *Reading annual reports from energy companies*

This is good place to gather a concrete picture of the interests and cost structure of the energy companies. The big question here is to find methods of analysis which help in analysing “reality” in certain categories and which are adequate with regard to the goal hierarchy and action organisation for the specific analysis. The above three general empirical methods are well suited to gather information at an action oriented aggregation level. Using the ways outlined under A, B and C is one way of localising an action-oriented level of aggregation in the analysis.

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This system includes Box A.1, the electricity supply service system, Box A.2, the national second order Governance system and the political process, and Box A.3, the EU energy sector regulation.

5. The general dynamics in an electricity system

We are now starting to describe the microstructure and its dynamics as a part of an analysis where we will end up by adding up the microstructures and their dynamics within the different components in Figure 6. The results will be a fragmented picture of the dynamics within Figure 6, the "Electricity supply service system and its second order governance system". This fragmented picture will then be used when evaluating the effects of electricity reforms and the interrelations between the Danish and the surrounding electricity systems.

The above effects should always be seen in relation to the goals of the electricity system, its specific governance situation with regard to the techno-organisational system and its historical point of departure or context.

Therefore, one should look at:

1. The *general* characteristics of "sunset technologies" and organisations, the importance/market share of which will have to decrease in favour of "sunrise technologies" which should enter the market/ increase their market share.
2. The *general* characteristics of the value-added change from fossil fuel energy systems to renewable energy systems.
3. The *specific* historic situation of the techno-organisational change.
4. The specific 1999 Danish organisational point of departure of the electricity supply service system, and its second order governance structure.

1 and 2 will be dealt with in this chapter, whereas 3 and 4 will be discussed in the succeeding chapters.

5.1 Some general characteristics of the technological change from uranium and fossil fuel (UFF) technologies to renewable energy and energy conservation technologies

The alternatives to uranium-, large coal-, oil-, and gas-fired power plants are electricity conservation, renewable energy and cogeneration technologies. Some of the differences between these new "sunrise" technologies, and the old "sunset" technologies are described in Table 1 below.

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Old techniques “Sunset technologies”	New techniques “Sunrise technologies”
1) Based upon a high level of fossil fuel and uranium consumption.	(1) Based upon energy conservation, renewable energy and integrated efficient energy supply systems.
2) Technical solutions are not contextually adaptable.	(2) Technical solutions differ from place to place.
3) Implementation in single purpose organisations.	(3) Implementation in multipurpose organisations.
(4) Sectored energy systems.	(4) Integrated energy systems.
(5) High degree of asset specificity; long technical lifetime, high capital costs and large strong organisations.	(5) High asset specificity, medium long technical lifetime, moderately strong organisations.
(6) Historically strong from a political point of view.	(6) Historically weak from a political point of view.
(7) Mostly using known techniques.	(7) Often demand new techniques.
(8) Often linked to existing knowledge.	(8) Often require new knowledge.
(9) Often based upon existing organisations.	(9) Often require new organisations.

Table 1. Characteristics of the “Sunset” and “Sunrise” technologies.

The alternatives shown in Table 1 indicate that the new technologies do not fit well in the organisation of the old fossil fuel and uranium technologies. This means that the organisations linked to these old technologies will be ill equipped to compete in the arena of the new technologies.

Consequently, one might expect heavy organisational resistance from the old technologies against the new technologies. This assumption has been confirmed in the Danish case over the last 25 years. This conclusion will be enforced, when discussing the value added changes for old and new organisations, when participating in this radical technological change.

5.2 The value-added chain and technological change

A main theoretical cognition here is that the motivation for innovation varies from firm to firm, and that this variation amongst others is a function of cost- and value-added structure.

5.2.1 The value-added question and the prototype uranium and fossil fuel electricity supply service system

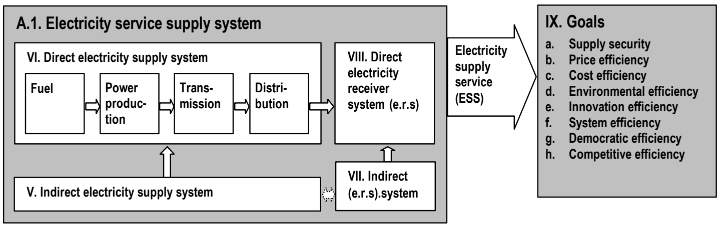

Figure 7. The direct and indirect Electricity Supply Service system
Source: Extracted from Figure 6.

Figure comments*: The structure of the figure has been discussed in Section 3.4, but here the following should be underlined. We find it important to include the indirect electricity supply system consisting of capital investment (V and VII), and the electricity receiver system including the investment in the equipment at the consumer level (VIII and VII). Furthermore, it is very important to evaluate the electricity system against a set of goals (Box IX).*

The Electricity Supply system
We are now dealing with the electricity supply system, Figure 7, Box V and VI.

The question is, what are the general characteristics of that system? This is an interesting question, since that system, comprising the existing main fossil fuel and uranium technologies, controls between 95% and 98% of the world's electricity market. At the same time, it is also a crucial investigation, as we are dealing with a system which, to a very large extent, has to be replaced with energy conservation and renewable energy systems within the next 20-40 years. Figure 8 illustrates the value-added flow in these systems. Here they are represented by the Danish system based upon large coal-fired power plants.

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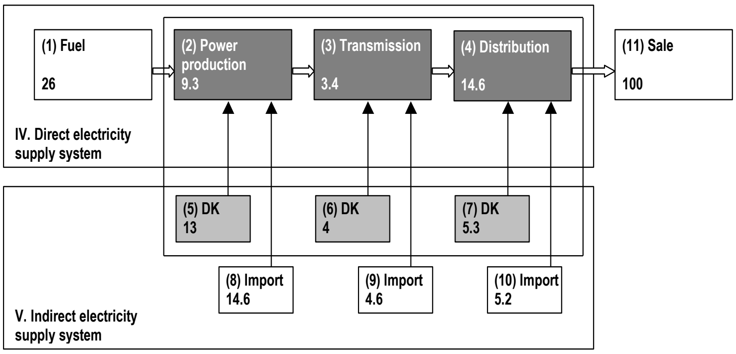

Figure 8. Value added distribution in a coal-fired electricity system[9, 10]

Figure explanation: *We have an electricity supply system delivering electricity at the consumer level for 100 value units, for instance, 100 DKK. Looking at IV. Direct Electricity Supply System, it can be see that out of these 100 DKK, 53.3 DKK is paid to the direct electricity supply system as a whole, with 26 DKK paid for coal, 9.3 DKK paid to the employees the power production stations, 3.4 paid to the employees at the transmission system, and 14.6 paid to the employees of the distributions system.*

*So out of 100 DKK**, 27.3 DKK** is paid to the employees in the direct electricity system.*

Looking at V, the Indirect Electricity Supply System, 46.7 DKK total is paid to the indirect electricity supply system, when combining the cost spent equipment for power production, transmission and distribution. Out of the 46.7 DKK, 13+4+5.3= ***22.3 DKK*** *is paid to Danish equipment producers, while 14.6+4.6+5.2=24.4 DKK goes to employees of imported systems.*

9 Source Calculated on the basis of SØ89-112, 10 April 1989 ELSAM, Statistic 1991, DEF, and Statistisk tiårsoversigter 1980-1989. The cost distribution between production and transmission is calculated on the basis of SØ89-112, ELSAM. In this calculation an interest rate of 1% is used, which was the inherent interest rate in the cost structure at that time. With a higher interest rate, the indirect electricity supply system would have a higher proportion of the 100 value added units.

10 It is worthwhile to remark that future electricity systems with no fuel use will ceteris paribus have a higher proportion of the value added chain within *direct and indirect* power production, transmission and distribution. Furthermore, it is probable that a higher proportion will be in the *indirect* electricity system.

Summarised, 22.3 DKK+ 27.3 DKK= 50 DKK is value-added within Denmark. This means that out of the 100 DKK, in this case 50% of the value-added is produced in Denmark and 50% is imported.

It should be mentioned, that Figure 8 does not distinguish between direct and indirect fuel production, and locates the whole fuel value added as a part of the direct electricity supply system.

The general knowledge we can draw from this, is:

1. An electricity service supply system has to be understood from the perspective of its organisational structure. A large part of the above-mentioned value added is organised under the same organisational "umbrella", mainly defined as an "ownership umbrella". If the same owners own the whole *"Direct Electricity Supply System",* this system will behave differently from a system which, for instance, does not encompass ownership of the fuel extraction companies. A system with close ownership links between the *direct and the indirect electricity supply system* will behave differently from a system without such links. The Danish system, until the electricity reform in 1999, was characterised as being vertically integrated between power production, transmission and distribution, but there is almost no integration of the equipment producers (the indirect electricity supply system, and of the fuel producers). So the Danish electricity system only integrates around 27% of the added value built into the electricity prices.

   This is very different from the traditional German electricity system, where the fuel sector is often integrated in the electricity system, and where there is also often a certain integration of the equipment producers through common ownership. The traditional German system, therefore, will have between 50% and 75% of the added value under the same ownership organisations.

2. Any talk about liberalization is usually linked to power production, transmission and distribution, or, in the coal-fired plant case in Denmark, around 27% of the value added built into the electricity prices. As transmission as well as distribution activities are not supposed to enter any free market competition, the liberalization reforms are, in practise, limited to the power production, which is 9.3% of the value added, or 9.3 % of the electricity prices in Denmark. We will make a detailed analysis of this argument, when we describe the links between the Danish electricity system and the "liberalization" process in depth.

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3. The indirect electricity system represents the fixed cost, when seen from the viewpoint of the owners, which are the organisations at the direct electricity scene. This system has a rather long life span linked to the plants, often between 20-35 years. Simultaneously, this system is characterised as having rather high fixed costs, which means that fuel costs plus personnel costs linked to the production are around 50% of the electricity prices "ab" power plant. The other 50% of the costs are linked to the initial investment and cannot be done away with if consumption decreases.

   It should be emphasised that this is only the case in a system, like the Danish one, where there is no ownership integration between power plants and fuel extraction activities. If such an ownership exists, like in Germany, a very large proportion of the fuel costs can also be regarded as fixed costs. This changes the orientation of the cost structure, as up to 70% of the costs in fuel extraction and power production become fixed costs. This also changes the behaviour of electricity companies, as their cost structure will differ on a short-term basis, according to the degree of vertical integration.

The electricity receiver system

When having the goals in Figure 7 in mind, it is important to acknowledge the fact that consumers do not consume electricity but services. The following example illustrates the importance of this observation. We now imagine that a consumer wants to buy 100 DKK worth of cooling at 7 degrees C in a box, a so-called 'refrigerator'. Figure 9 illustrates the "value-added" implications of this situation.

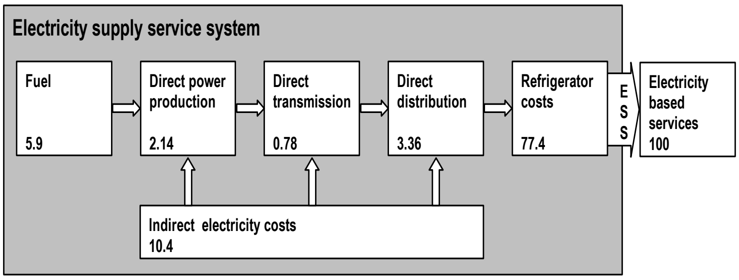

Figure 9. The value added chain for an electricity-based refrigeration service supply system

Figure explanation: *The same general assumptions as in Figure 7, plus the following assumptions regarding the costs of refrigeration: 5000 DK refrigerator, 10 year life span, 300 l capacity, 200kWh annual consumption, electricity price: 1 DKK/kWh, 5% p.a. interest rate.*

The figure shows that the transformation of electricity to *cooling service* represents more than 77% of the total cooling service costs in this specific case. Naturally, the proportion would be different if the refrigerator used 400 kWh instead of 200 kWh/year.

From Figure 9 we can observe that the *direct electricity supply* system only accounts for 6.3% of the price for cooling services and that the *direct power production system* only accounts for 2.14% of the price for cooling services. In regard to cooling services, this puts the whole Danish "liberalization" into perspective, as the only part of the value added chain that is to some extent liberalized is the "*Direct power production",* which, in the Danish case, represents only 2.14% of the price of cooling services.

So when we look at the goals of the electricity supply service system, it is important to recognise that these goals, in many cases, are only achieved if also the *electricity receiver system* is working efficiently. This is especially important where the *electricity receiver system,* as in the above refrigerator case, represents about 70-80% of the value-added in the whole *electricity supply service system.* Thus, it is quite possible to have a direct electricity supply system which functions efficiently as far as the goals of the electricity supply service system are concerned. But at the same time, the electricity supply service system as a whole can function very badly if there are problems within the institutions governing the development of the electricity receiver system. The opposite could also be the case with a poorly functioning direct electricity supply system and a well functioning direct electricity receiver system, resulting in an acceptable performance of the electricity supply service system as a whole.

5.2.2 The value-added chain of upcoming electricity systems

The present electricity system in Denmark includes wind power production amounting to 12% of the total Danish electricity consumption as well as some development of biomass-based electricity production. Upcoming developments will probably also include the extensive use of photovoltaic and wave energy-based electricity production. Further use of windpower will require the introduction of regulation facilities synchronising the wind power production with the consumers consumption needs. But what are the typical features of these "new" non-fossil fuel and non-uranium technologies, when

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described with the same “value-added chain” methodology, as we have used above? Figure 10 deals with this question.

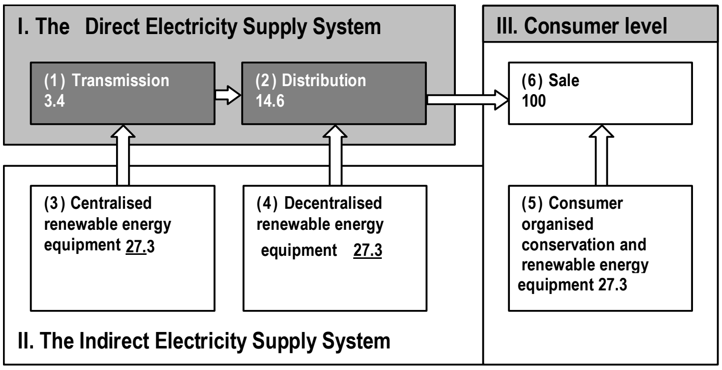

Figure 10. The value added chain of upcoming renewable energy and conservation systems

Figure explanation*: The assumption is that the renewable energy system can produce energy at the same price and with the same transmission and distribution grid as the current network system. A further assumption in this example is that the renewable energy technologies are distributed in such a way that one-third of the indirect electricity supply system will be linked to the central transmission level, one-third to the decentralised distribution level, and one-third to the household level. With these assumptions, the value-added distribution will be as shown in Figure 10.*

Figure 8 shows thevalue-added chain in a typical "sunset" coal/uranium based electricity production system. Figure 10 illustrates a typical "sunrise" renewable energy conservation value-added chain at the energy scene. In the following sections we will analyse the consequences of establishing a transition between the "sunset" technology value-added chain in Figure 8 and the "sunrise" technology value-added chain in Figure 10.

5.3 The neo-classical "dot firm" paradigm

In neo-classical economic theory firms are **“dots”** with no described internal organisational life. The firms are solely characterised by their outcome, profit maximisation, which usually is not discussed in depth with regard to the exact meaning of profit maximisation. In neo-classical economic theory, there is no difference in the internal political and economical incitement mechanism between an established power company owning large coal-fired power plants and a newcomer organisation with regard to their motivation for investing in new renewable energy and conservation technology.

These firms are all viewed as identical **"dots"** with the following characteristics:

- Having the same pollution abatement costs. The costs and value of production of a windmill is the same within an organisation producing coal- or uranium based electricity as in a firm, which is independent of coal and uranium.
- Pursuing profit maximisation. More importantly, the outcome of this profit maximisation motivation will be the same, independently of the cost structure, culture, and institutional context of the firms in question.
- Having the same organisational dynamics and relationship to the outside world.

It is when such basically identical (with regard to motivation dynamics) **"dot firms"** meet each other on the market that the "curve exercise" with marginal cost-, supply- and demand curves can get started.

Figure 11 shows a typical neo-classical perception of the supply and demand situation. This then can be influenced by means of a general public regulation policy, which does not differentiate between the different motivation structures of different industries.

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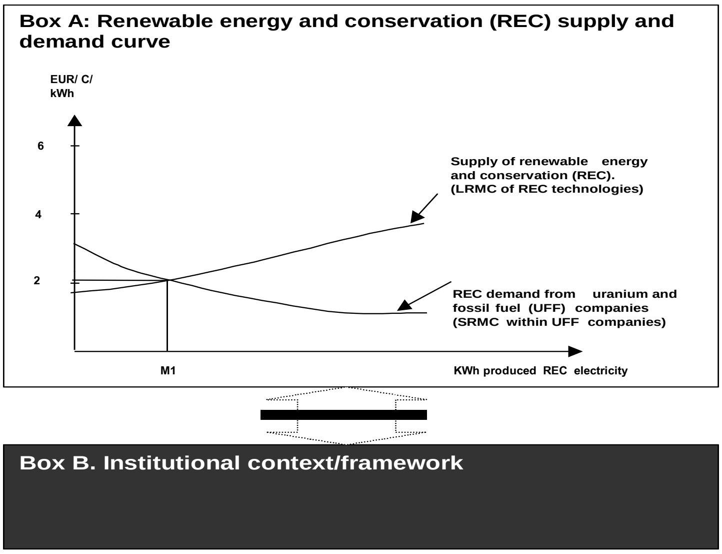

Figure 11. The neo-classical supply and demand thinking

Figure explanation*: There is a demand curve and a supply curve for renewable energy. The firms and consumers will buy renewable energy as long as its marginal costs are lower than the marginal costs of the present alternatives. In this case, the amount M1 will be bought at a price that is a bit above 2 EUR/C/kWh. It is typical for this type of economical modelization that detailed institutional conditions are not analysed. They are kept in the black box B.*

The interesting characteristics linked to this way of thinking are that there is no discussion of any differences in the motivation structure from firm to firm. It is via the focus of the "model" supposed, that all firms are demanding renewable energy technologies, when these have long run marginal costs (LRMC)[11] which are lower, than the LRMC of the present technoorganisa-

[11] Usually, LRMC is defined with a given technological development and thus not including the innovation potentials usually linked to newcomer technologies. Since around 1980, the LRMC has decreased by 80% for wind power. This type of cost changes cannot be analysed by means of the above supply and demand curve methodology.

tions. There is no analysis of the different motivation structures of different companies as a consequence of differences in the amount of investments and organisational engagement already undertaken (sunk costs) or as a function of organisational cultures already established[12].

5.4 The "institutional economy" paradigm and firms as differentiated organisms

It is one of the major conclusions in this publication that for our purposes it is not of use to consider firms as identical and neutral **"dots"** behaving in a similar way on the market[13]. Methodologically, this is illustrated in Figures 6, 7, 8, 9, and 10, where it is demonstrated as necessary to be aware of the following.

Firms should be regarded as different with regard to:

- Internal dynamics illustrated by different value added structures in different situations and in different firms (Figures 7,8,9,10).
- Internal organisational dynamics in different situations of change and different types of firms.
- Lobbyist ability and links to the regulators (Figure 5).
- Motivation for new renewable energy- and conservation technology, where fossil fuel firms are mainly attracted to "end of pipe/end of chimney" solutions, whereas new firms, which are independent of fossil connections, have a stronger interest in totally innovative technologies (Figure 6).

Lobbyists should, as underlined in the Figure 6 structure, be divided between the ones who are economically bound to the old fossil fuel and uranium solutions, and the ones who are economically independent of these connections.

The Parliament should be regarded as an organisation which is able to establish a process of innovative democracy, making it possible for the "majority", which is economically independent of narrow economic interests on the energy scene, to design, choose and implement new technological solutions, if necessary, against the interest of the "minority", consisting of strong and

[12] This should not be considered as any attack upon neo-classical thinking, but rather as a defence. The really dangerous attack upon a (and any) theory is usually performed by its "friends" by not considering its assumptions, character end area of use.
[13] We still believe that firms are pursuing a profit maximization strategy, and that "at the end of the day", the winners will be the firms having the most successful "profit maximation" practice.

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concentrated economic interests in specific fossil fuel- or uranium-based technologies.

Some short examples will show the consequence of looking at firms as dynamic and differentiated organisms. First we will look at the combination of the supply demand curve thinking, and the institutional analysis linked to looking at firms as being different with regard to culture, and economic incitement structure.

5.4.1 Value added, cost structure and the dissimilarity of investor behaviour

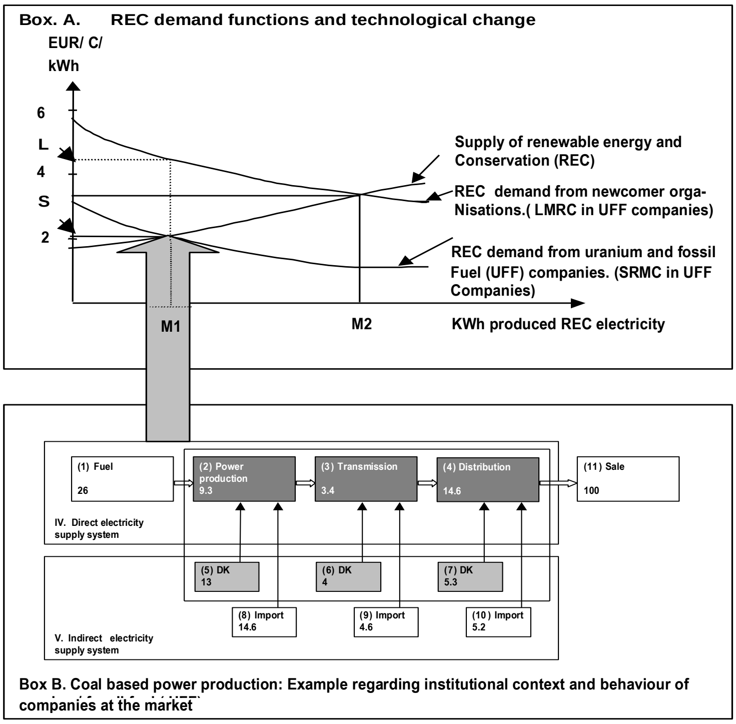

Figure 12. Cost structure and a "synthesis" of the institutional and neoclassical approach

Figure explanation/discussion:

Box A*:* We have the same renewable energy supply curve as in Figure 11. But now we have two REC demand curves, namely the lower one coming from a market with excess capacity, and showing the short-run marginal costs (SRMC) of existing energy technologies. In this case, it is the same as in Figure 11. The upper curve represents the long-run marginal costs of existing production technology (LRMC).

The figure represents a situation where the established uranium and fossil fuel companies are the only-, or at least, the totally dominant investors at the energy plant investor market, and are characterised by the cost structure of uranium and fossil fuel companies. These companies have relatively low short-run marginal costs (SRMC), high capital costs, and a very long lifetime once the investment has been made)[14]. For these potential investors, it generally does not pay to invest in REC technologies, as they already have invested in uranium and or fossil fuel technologies. The lower demand curve, mentioned as representing their short-run marginal costs in many periods, therefore, will be the costs they are saving if they invest in REC technologies. The result of this demand curve is an investment in M1 REC capacity, and a price on REC electricity on around 2 EUR/C/kWh.

The upper demand curve represents the long-run marginal cost function (LRMC), which, seen from independent investors is the crucial one, when investing in new REC technologies, and resulting in the invested amount M2, and a price on REC electricity on around 3.5 EUR/C/kWh.

The link between Box B and Box A: The vertical arrow, illustrating the location at the two curves of a coal-based electricity system, represents the link between Box B and Box A. The lower curve represents, as mentioned above, the actual market behaviour of the UFF companies with M1 as the demanded amount of REC technology (Amount M1 and price S, which is a bit above 2 EUR/C/kWh). When dealing with the long run marginal costs of the coal-based electricity system, it is found at the upper curve, and is L (in this case a bit more than 4 EUR/C/kWh). In this theoretical figure, we imagine that there are UFF technologies which can produce cheaper than the shown coal case, and that the LRMC line of the UFF technologies is crossing the LRMC of the REC technologies for an amount of M2 kWh REC based electricity production and a price around 3.5 EUR/C/kWh.

Seen from the point of view of society as a whole, the LRMC function is representing the socio-economic costs of electricity production (excluding

[14] Often 30-40 years for large coal or uranium based power plants.

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environmental costs), which is why the M2 amount and a price around 3.5 EUR/C/kWh is closest to the socio-economic optimum situation.

Box B: Here the value-added chain in a typical coal-based electricity system is shown to have the characteristics discussed under Figure 8. Here we are emphasising its connection to the concepts of long and short-term marginal costs.

Seen from the perspective of an electricity system, like the present Danish system, which is only organising production, transmission and distribution, and not fuel extraction, the short-run marginal costs will be found within the Direct Electricity Supply System (Boxes 1,2,3,4). From the perspective of the management and the employees in the company, the short-run (1-2 years sight) marginal costs will only be fuel costs plus some part of the labour costs, mainly at the power plant level (Box B (2)). In the Danish system, this amounts to around 30-35% of the electricity price.

The rest will be capital costs and necessary labour costs linked to the production, transmission and distribution of electricity. The fixed costs encompass from this viewpoint 65-70% of total costs. The investments in fixed capital are, for our purposes, especially interesting, and are shown in the indirect electricity system in Boxes 5,6,7,8,9,10. These investments, often having a lifetime of 30 years, constitute in the Figure 12, Box B, 46.7% of the final electricity price.

In Figure 12, Box B we have described the specific economic characteristics of a specific way of producing electricity, namely coal-based power production in the Danish structure of vertical integration, at a given historical time. In Example 1, Table 2, some of the consequences of the Figure 12 description are illustrated.

Example 1. The different motivation between uranium-fossil fuel based investors (UFF investors) and independent investors for investing in renewable energy and conservation (REC) technologies.

	UFF investors		Independent investors	
	% of value-added	**EUR/C kWh**	**% of value-added**	**EUR/C/ KWh**
A. LMRC for 1 kWh coal-based electricity production.	100 %	6.6	100%	6.6
B. SRMC 1 kWh coal-based electricity production. (fuel + some labour costs)	35 %	2.3	100%	6.6
C. LMRC of 1 kWh REC (Renewable energy/conservation)	120%	7.9	120%	7.9
D. Needed minimum REC subsidy	120-35 = **85% of coal LMRC**	**5.6**	120-100= **20% of coal LMRC**	**1.3**

Table 2. Necessary minimum subsidy for the implementation of renewable energy/conservation (REC) technologies.

Assumptions: The value-added distribution is basically taken from Figure 12, Box B. One kWh of coal-based electricity is produced with total costs of 6.6 EUR/C/kWh including transmission and distribution. The short-run marginal costs linked to this production are 2.3 EUR/C/kWh, as shown in Figure 12, Box A., and, as discussed above, within a realistic range of SRMC for coal-based systems around 2000. The specific REC technology in this case costs 7.9 EUR/C/kWh, which is 1.3 EUR/C/kWh more expensive than producing electricity at a coal-fired plant (excluding environmental costs). Nevertheless, it is a parliamentary goal to decrease electricity consumption by one unit in this case. The question now is how this new REC technology can be furthered with the least possible public expenditures/subsidies?

If we want the coal-based electricity supply system to invest in one kWh REC production, we will have to pay a (7.9- 2.3)EUR/C/kWh in subsidy. The UFF company has “sunk costs”, since it has invested in power plants, distribution and transmission lines, and only has 2.3 EUR/C/kWh in short-run marginal costs. Consequently, the company produces electricity at a short-run marginal price of 2.3 EUR/C/kWh. As the specific conservation and renewable energy technology in question costs 7.9 EUR/C/kWh, the

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coal-based company only has an investment motivation, if the subsidy is higher than 5.6 EUR/C/kWh.

The new independent organisation is paying 6.6 EUR/C/kWh for 1 kWh of electricity, while its potential customers for conservation units or REC production units also pay this price. The new independent REC technology producer, therefore, would start producing REC based electricity, if the subsidy were above 1.3 EUR/C/kWh.

Therefore, it is much cheaper for public funding to encourage independent production of energy conservation than to motivate the coal-based company.
Example 2. Economic losses and decrease in green innovation, due to short run marginal pricing

At present, the establishment of the Nordpool and Leipzig markets for electricity, in combination with excess power plant capacity, results in electricity prices, which are around 1.6 EUR/C/kWh (2000 average at Nordpool), and close to the short-run marginal costs of coal-fired power plants. At the same time, the long term costs, including capital expenses but excluding external pollution costs, are around 3.3-3.5 EUR/C/kWh/kWh for large coal-fired power plants. So on a long term basis, any technology which can produce electricity at a price lower than around 3.3 EUR/C/kWh represents an economical improvement for society. However, the 1.6 EUR/C/kWh price signal is massively present on the actual Nordpool market, which means that any new technology that could, for instance, produce electricity for between 1.6 and 3.3 EUR/C/kWh, will not be able to enter the market. We, therefore, are currently in a situation where excess uranium and fossil fuel capacity hinders the development of new technologies, if these new technologies are forced to sell at the Nordpool market price. This is illustrated by Figure 13.

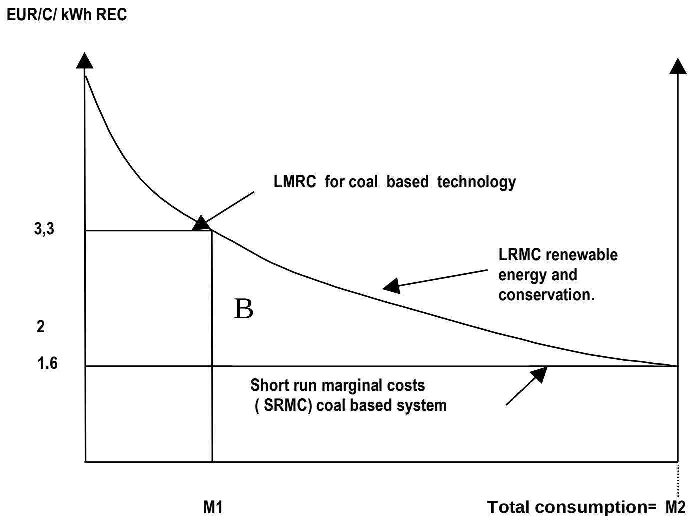

Figure 13. Production distribution in *period 1* with excess capacity.

Comments: *The total consumption is M2 TWh at a given point of time. This consumption then has to be produced by a combination of technologies. We are in a situation where the short-run marginal costs (LRMC) are 1.6 EUR/C/kWh for the existing coal-based power systems, and the long run marginal costs (LRMC) 3.3 EUR/C/kWh. The long-run marginal cost function of renewable energy and conservation technologies in this case goes from 6 EUR/C/kWh down to 1.6 EUR/C/kWh.*

As there is excess capacity, the market behaves according to the short run marginal costs. In the prevailing situation, the coal-based production will be an amount of M2 at a price of 1.6 EUR/C/kWh. No REC-based electricity will be produced. The potential renewable energy and energy conservation producers are producing nothing, although this technology, in the particular case, is supposed to be able to produce the difference between the M2 amount and the M1 amount at long term marginal costs, which are lower than the long term marginal costs of coal-based electricity production. As there is surplus coal-based capacity, *the society gains*[15]*, in period 1, area B,*

[15] It should be underlined that the bare exixtence of excess capacity represents a loss

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by not building new REC capacity, and instead uses the surplus coal-based capacity. The loss is lack of technological development, as, during period 1, no new technology has been developed. We will now look at period 2 in Figure 14.

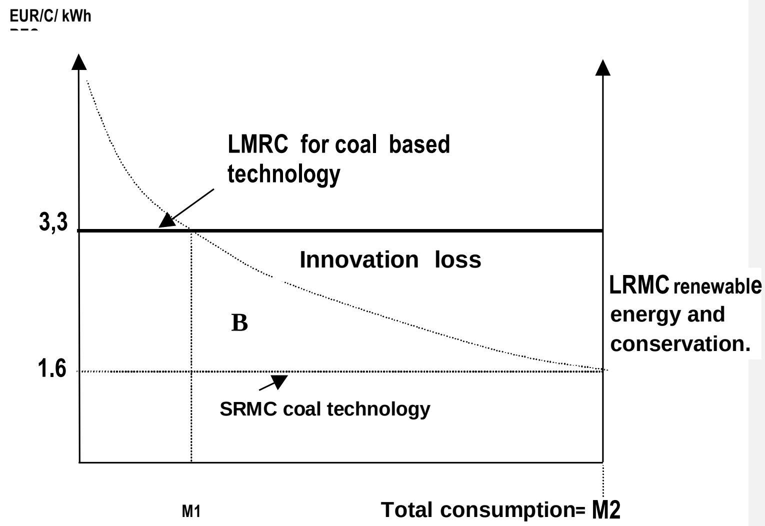

Figure 14. Production costs and production method in *period 2 without excess capacity*

Comments: As we did not develop the cheaper REC in period 1, when the coal system had excess capacity and “dumped” the prices with short run marginal cost based prices, we also have to use coal in period 2. The main investment problem here is that one never has a "clean blackboard" from an investment point of view. The coal power plant investments are interlinked over time, and the alternative REC technologies were, due to the SRMC pricing in period 1, not developed. Therefore, we have to build a new generation of coal-based technology, and for reasons of simplicity, we assume that

due to investment in over-capacity. This means that before, the start of the above "case" the owners of the coal-fired plants have charged society with the costs of establishing excess capacity. This- for instance- is the present case in Denmark, where the established excess capacity was paid for by the consumers during the nineties.

the new coal-fired power plants have the same long run marginal costs, 3.3 EUR/C/kWh, as the old coal-fired plants. The area below the long run coal marginal cost curve of coal power, above the dotted LRMC REC curve, and between M1 and M2, now shows the loss due to lack of investment in the new REC technologies. In this case, the innovation loss in period 2 is higher, than the gain[16] linked to using surplus coal capacity in period 1, as shown in the area here called B.

In reality, there is an almost automatic retaliation from old technostructures, when newcomer technologies are successful on the market.

The sequences of automatic reaction are the following:

a. Newcomer technologies are successful and the market decreases.
b. There is surplus capacity on the market.
c. Prices are based upon short-term marginal costs on the markets.
d. Newcomer technology markets decrease/ are extinguished.

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This automatic reaction is to a large extent built into the present "liberalization" regime, where the public regulation does not hinder market "dumping" by means of SRMC pricing. A "liberalization" regime, which should be succesful from an innovation point of view, should include public regulation measures that are securing a LRMC pricing regime at the market when paying for electricity sold from new REC technologies.

5.4.2 Technological change and the value-added loss of fossil fuel and uranium based companies

The characteristics of the value-added change from fossil fuel and uranium based to renewable energy systems

One way of describing this situation of change is to combine Figure 8 with Figure 10, as it is done in Figure 15 below.

[16] Once more, it should be emphasised that this gain is a result of historical " "over-investments" in capacity, which have been expensive for society.

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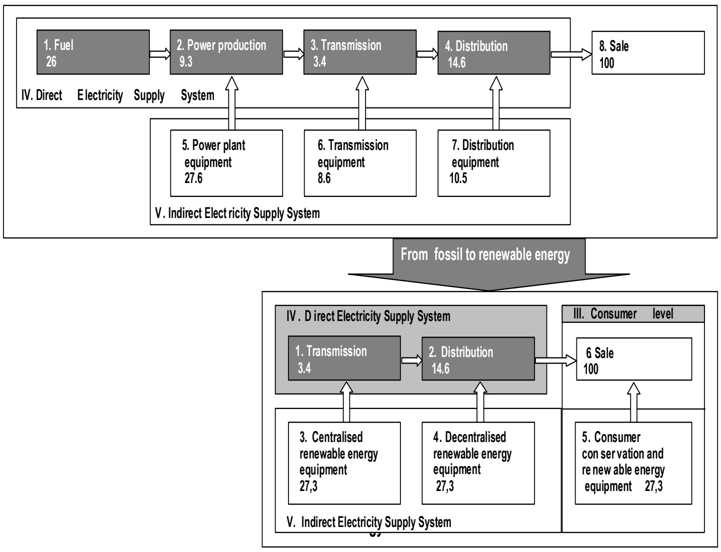

Figure 15. The change in value-added profile connected to the change from uranium and fossil fuel -, to renewable energy and energy conservation systems.

Figure explanation*: In the old fossil fuel based system a 100 Dkk sale at consumer level will have the value added divided between the different levels of vertical integration as shown in the upper figure.*

The figure at the bottom shows the value-added distribution in an energy conservation and renewable energy system.

From Figure 15 we can observe that the value-added chain of renewable energy and conservation (REC) technologies differs clearly seen in relation to the value-added chain in a fossil fuel based system within two areas:

a. In the REC value-added chain, the fossil fuel value-added part has disappeared, and is replaced by investment in renewable energy capital equipment.
b. In the REC value-added chain, the power production value added in a specific direct electricity supply system organisation has been replaced by *"renewable energy system automation"*, where it is probable that the

maintenance, at least at the decentralised and consumer level, will be performed by the suppliers of the windmills, the photovoltaic cells, the hydrogen production system, the electricity battery charging system, etc. The need for a specific power production organisation might decrease or disappear, as the day to day work on a power plant has been replaced by automatons requiring maintenance from, for instance, the windmill factory.

It is naturally possible that the existing power company organisations will take over the maintenance of the renewable energy automatons, especially those connected with the large renewable energy plants at sea. But even in this case, the added value directly linked to the power sector will only be halved compared to the present day.

As a consequence of (a) and (b), the direct electricity supply system organisation might therefore decrease until it only consists of the transmission organisation and the distribution network organisation.

Consequently, a main characteristic of technological change, as illustrated in Figure 15, can be that the part of the indirect electricity supply system which directly relates to equipment for power production. Transmission and distribution might increase from today's 46.7% of the total value added in the fossil fuel system to, in this Figure 15 case, 81 % of the added value in a renewable energy system. This is mainly due to the fact that fuel import is replaced by renewable energy equipment/capital.

An electricity system, like the German one, with its ownership integration of fuel extraction, power production, transmission and distribution would decrease in value-added share from 50-60% of the electricity price to around 20%, if successfully introducing REC energy automatons. This might heavily reduce the profit base of these companies, and reduce the share value considerably.

In an electricity system like the Danish, the value-added decrease would be considerably lower, from around 27% to around 18% of the electricity price.

We can conclude that the people and organisations linked to the old system are simultaneously losing value-added, since their organisations have no comparative advantage, when dealing with the new technologies. The jobs and profit thus go to new technological systems with very different value added profiles and organisational "needs". Because of this, the old fossil fuel organisations can be expected to fight against the new green energy technol-

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ogies. REC technology, therefore, certainly does not motivate the uranium and fossil fuel companies for any expansion of the REC technologies at the market.

5.5 Conclusion regarding the resistance against renewable energy and energy conservation from the existing uranium and fossil fuel (UFF) companies

5.5.1. The causes of UFF resistance against renewable energy and conservation

There are two main lessons, when going from the "dot firm" understanding to an understanding of firms as different "personalities" with regard to cost structure and business culture. The first is that these differences result in very different behaviour with regard to acceptance of new technologies. The second lesson is that this has important consequences, when designing an innovative energy policy.

When one changes from a Neo-classical “dot firm” understanding to an organic view dissecting the culture and internal cost structure of firms, it becomes perceptible that different firms will react differently to the introduction of renewable energy and conservation technologies. In general, new firms, which are politically and economically independent of the old uranium and fossil fuel based energy companies, will display a much higher degree of cultural and economical acceptance of the new REC technologies than the old uranium and fossil fuel based energy companies. In most cases, the old uranium and fossil fuel companies have exerted a systematic resistance against the "innovation risk" which is coming from the new REC technologies.

When concluding about the causes behind the resistance of old fossil fuel and uranium based technologies against renewable energy and conservation (REC) technologies, the following can be stated.

(a) The decrease in value added and profit

The new REC technologies represent a development towards energy automatons[17]. This shifts the value added away from the traditional electricity sector

[17] Automatons in the sense, that almost the whole value-added is produced at the equipment producer level. In this sense, a better insulation standard in refrigerators can be considered as an energy automaton.

towards the renewable energy and conservation equipment producers. Consequently, this type of technological change will decrease the value added in existing power systems by 50-80%. The turnover linked to the area of electricity production, transmission and distribution will decrease and be transferred to the "energy automaton" manufactories. See Figure 11, where the turnover in an electricity sector of the Danish type is decreased from 27.5% of the electricity price to 18.2%. Furthermore, in a German type of electricity system, where coal extraction is integrated as a part of the large power companies, the turnover will fall from around 50-60% of the value-added chain to the above mentioned around 18%.

The above decrease in value added will result in considerable profit losses in the existing uranium and fossil fuel based electricity companies. It therefore is understandable that these companies are working systematically against the new REC technologies.

(b) REC shows a bad economy within the uranium and fossil fuel companies.
In many periods, the uranium and fossil fuel companies have their own short-run marginal costs as opportunity cost. When these companies are considering implementing renewable energy and conservation technologies, the REC technologies, therefore, will often be evaluated against these SRMC opportunity costs. Consequently, the long-run marginal costs of the REC technologies are compared with the short-run marginal costs of the UFF companies, and REC technologies therefore will show up as economically not feasible within UFF companies.

(c) REC technologies require another technical regulation infrastructure, than UFF technologies.
This question is discussed in (Hvelplund, 2001), (Lund, 2000). The uranium and fossil fuel technologies represents large production units, which requires a considerable "high tension grid system". REC technologies, in general, are fluctuating in accordance with the used natural resource (wind, sun, waves, etc.). Therefore, an infrastructure that can handle these fluctuations is needed. This REC infrastructure is very different from the "high tension grid system", which is the infrastructure system of the large UFF power plants. REC technologies, consequently, are getting economical problems, when forced into the "high tension grid" infrastructure of the UFF power system.

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(d) The UFF companies have neither any organisational nor a know-how-based comparative advantage, when implementing REC technologies.
A transition from UFF to REC technologies, therefore, represents a change, where the UFF companies are losing their present comparative advantage with regard to technical as well as organisational know how (see Table 1).

It is important to realise that it is the synergistic effects of the above resistance causes which constitutes the accumulated resistance from the UFF companies against the REC technologies. Theoretically, one could maintain that UFF companies will invest in REC technologies when their LRMC is lower than the LRMC for their UFF technologies, once the excess capacity situation had ended. The argument would then be that the UFF companies might very well act according to their short-term marginal costs during a period of excess capacity, but after this period, they again would invest in new technology in accordance with their long-term marginal opportunity costs. However, in this process they would tend to invest in technologies, which could secure a continuation of the present value-added distribution in electricity production. This would result in a continued investment in UFF technologies. Therefore, when combining the SRMC opportunity cost problem with the "decrease in value-added problem", the UFF companies basically have no long-term interest in a transition to REC technologies. They rather would use the SRMC problem as a political tool in order to convince the politicians, that they should not support REC technologies at present, as " there is excess capacity".

In Table 3 the "causes of UFF resistance" against renewable energy and conservation technologies are summarised. The table, furthermore, is listing the core factors that might increase the resistance coming from the UFF companies. This is done in order to underline that there are also difference between different UFF companies, depending on their specific capital and ownership structure.

I. Categories of ***resistance***	II. Factors increasing resistance
(1) Loss of value-added share (Figure 15)	a. Degree of automisaton of electricity production. b. Degree of transition from energy supplies to energy conservation. c. Degree of vertical ownership integration. d. Degree of ownership integration between electricity system and equipment producers.
(2) Short run marginal costs as opportunity costs. (Figure 12,13 and 2)	e. Periods with excess capacity. f. Long power plant lifetime. g. High capital costs. h. High degree of vertical ownership integration. i. High degree of ownership integration of electricity system and equipment producers.
(3) Different electricity regulation infrastructure[18]	j. Degree of political power linked to "old" transmission line infrastructure.
(4) Loss of organisational and know how based comparative advantage. (1)	k. The higher degree of automisation. l. The higher degree of transition from supply- to conservation technologies.
(5) Type of profit dependency	m. The higher degree of "financial market" sensitivity.

Table 3. Causes furthering resistance from UFF organisations against REC technologies.

Comments regarding factors which are increasing UFF resistance against REC technological innovation:
-The loss of value-added share is high, if the value added goes down from the direct to the indirect electricity system. It is even higher, if there is a shift away from the supply side to conservation investments at the consumer level. Seen from a "loss of value-added" perspective, renewable energy technologies are bad for the UFF companies, but electricity conservation is worse. Whether a loss of value-added is resulting in a big profit loss, depends upon how much a company has to lose. The Danish electricity system neither has the fuel value-added, nor the equipment producer value-added within its organisation. It therefore from the start has only around 27% of the

[18] See: "Renewable energy Governance systems", (Hvelplund 2001).

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total value added share to lose. The German electricity companies mostly have very close ownership connections to the coal production, and to some equipment producers, and therefore have a value-added share of around 50-60% of the electricity price. They consequently have more to lose than the Danish electricity system.

- The Short run marginal cost (SRMC) problem is most serious in periods with excess capacity. It is increasing for power plants with relatively high capital costs and a long lifetime. This would be large modern coal fired- and nuclear power plants, with a life time of 30-40 years, and capital cost amounting to around 50-60% of total costs. It is even higher in hydropower systems and in coming renewable energy systems (wind-, solar- and wave power). The short run marginal costs are lower the larger a part of the total value-added chain Electricity Company owns. This means, that the German electricity system has lower short term marginal costs, than the Danish electricity system, due to the German ownership structure with coal extraction firms being owned by the electricity companies. So one should expect a tougher resistance against REC technologies from the German power companies, than from the Danish electricity companies.
- The type of profit dependency is a function of the concrete ownership structure. The present Danish consumer- and municipality owned electricity system does not at all have the same profit pressure, as the German shareholder ownership structure. The Danish electricity system lost 30% of its market during the nineties to wind power and small cogeneration plants without it giving serious problems. No shares lost their value, as there was no shares.

5.5.2 The institutional context of the UFF resistance against renewable energy and conservation.

Figure 16 shows the macrostructure or context in which we find it worthwhile to place the above concrete "micro level" institutional conditions. The figure is identical with figure 6.

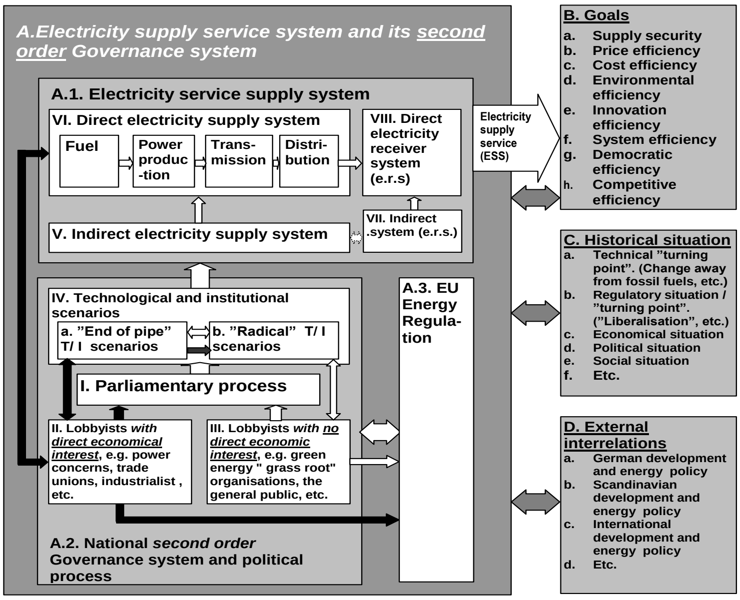

Figure 16. The context of technological rivalry
Source: Identical with Figure 6.

In Chapter 5.4. and section 5.5.1., we have dealt with the dynamics within the boxes V, VI,VII and VIII, by mainly analysing the electricity supply system. This discussion culminated in the conclusion that existing uranium and fossil fuel companies have an array of cultural and especially economic reasons to counteract the development and implementation of renewable energy and conservation technologies. In Figure 16, the black arrow coming from the direct electricity supply system, box VI, passing through box II, the lobbyists, and then influencing the national Parliament and the EU, is the essential one here. Through this channel of influence, the perception of reality influenced by the economical incitements discussed in Chapter 5.4. are forwarded to the politicians. As seen illustrated in the figure, the contents of this influence has been, and as seen in the preceding chapters, will have to be supporting "end of pipe" uranium and fossil fuel based technological solutions. The "radical technological changes" will need to have other supporters. That is why we are dividing the lobbyist group in Figure 16 into economically dependent and economically independent lobbyists. So the design

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of the macrostructure in Figure 6/16 is also a consequence of the analysis in Chapter 5.4. The above macrostructure/context is describing a situation of technological rivalry, where it is necessary to establish a sort of **double governance system** with economically independent groups influencing the long term innovative policy at- in this case-the energy scene.

6. General principles of regulation and the characteristic electricity systems around the year 2000

The aim of this chapter is to establish a consciousness regarding the different channels of regulation that can be used when governing large infrastructure projects like the electricity system. This is important as a counterweight to the present stereotypical discussion dealing with market contra public regulation. When this discussion is a bit more advanced, it deals with the "double" regulation of the "adequate" combination of market and public regulation.

What is needed, as will be argued here, is a three-line regulation strategy comprising public regulation (Parliament), the marketplace, and consumer ownership, all placed in a context with an open communication policy combined with an independent press. This conceptualisation of the regulation question is illustrated in Figure 17.

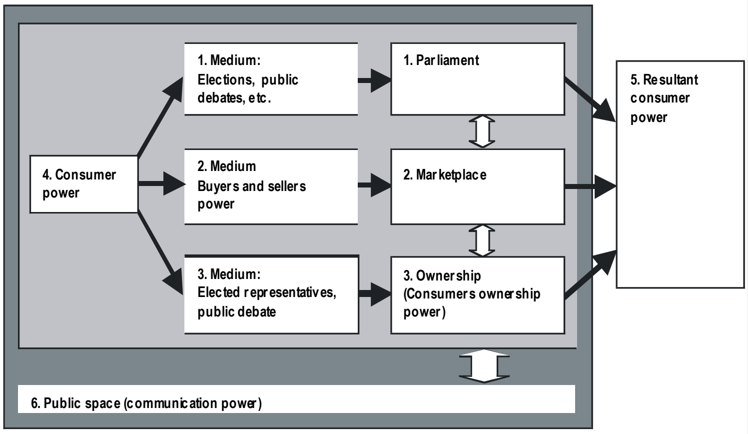

Figure 17. "*Four - line*" consumer power.
Figure explanation: *The figure shows that the consumers have four main lines through which they can exercise consumer power, namely through the Parliament, the marketplace, consumer ownership and the public communi-*

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cation spere. Combined, these channels of power become the "resultant consumer power" (Box 5). Whether this type of four-line consumer power system will be efficient or not depends on the communication context as it is developed in the public space (Box 6).

The specific feature linked to Figure 17 above is the introduction of *ownership power*, which often is not included in economic textbooks or the scientific models dealing with the development of the energy sector. The inclusion of *ownership power* is closely linked to the Danish experience, as Denmark has a long tradition of consumer ownership in many sectors, and also in the energy sector. When linking our discussion of liberalization to the above three-line power division, it is interesting to note that the ongoing liberalization policies only use one of the regulation lines, market power regulation. Moreover, the ongoing liberalization policies also only deal with around 10% of the value-added chain, namely, power production, as shown in Figure 8. None of the current liberalization models suggests liberalizing transmission and distribution services. If we consider the deeper purpose of liberalization to be consumer control via purchasing power, then the 10% of the value-added chain mentioned above, power production, is the only part of the electricity supply system that can potentially be liberalized through the market channel (Box 2 in Figure 17)[19].

Consumer power over transmission and distribution monopoly networks, amounting to 18% of the added value of the direct electricity supply system, can then, logically, only be exercised by means of consumer ownership control or public regulation (Boxes 1 and 3 in Figure 12). The Danish system has, so far, been characterised by the use of consumer ownership power as the control mechanism hindering the development of monopoly profit in the transmission and distribution networks, as well as in the power sector.

The conclusion here is that only the "right" balance between public regulation power, market power and consumer ownership power makes it possible to pursue the goals for electricity production, as they are shown in Figures 6. The value-added chain requires the skilled use of all three governing mechanisms at the same time. But this is not sufficient; it is also a necessity that the

[19] It should, though, be mentioned that even these 10% will represent huge difficulties, due to the cost structure, long lifetime and asset specificity of power plants. These characteristics make it extremely risky to invest in power plants on a free market with many mutually independent producers. Thus, the ongoing tendency will be to establish different types of market cooperation such as mergers, "strategic collaboration" (the new word for cartels), etc., with the intention of controlling market forces and decreasing competition.

communication context in which these governing mechanisms are used be endowed with a certain democratic standard, including extensive public access to information regarding costs and price levels and structures.

In Table 4, the strengths and weaknesses of the three governing mechanisms are succinctly listed in order to show how and why they each have a role to play.

	Strengths	**Weaknesses**
Parliament ***Public regulation power***	**a**. Can include "external effects" outside the direct buyer/seller relation. **b**. Can remove barriers to entry and support new technologies by mobilising the public.	**c.** Not precise, when dealing with the specific communication between buyer and seller. **d**. Strong tendency to be captured. The strong actors on the market can control the regulator, i.e. the State.
Market ***Buyers' and sellers' power***	**e**. Provides a precise tool for quick day to day regulating of the specific communication between buyer and seller.	**f.** Cannot include external effects. **g**. Tendency to degenerate into **short-term prices** monopolies/ oligopolies. **h.** Easily degenerates into **long term technological system monopoly** hindering the introduction of "radical new" technologies.
Ownership ***Consumer ownership power***	**i.** Ensures that there **is no third agent** between the consumer and the producer. This can counterbalance the "capture" weaknesses of both public regulation (d) and the market (g). **j**. Favours the implementation of concrete technical solutions.	**k**. Some owners can make alliances, and, in that way, achieve price privileges. **l.** If democratic channels prove too weak to ensure democratic control, it could result in cost inefficiency. **m**. Tends to be unable to change the techno-organisational direction and work against **"radical new technologies".**

Table 4. Weaknesses and strengths linked to different governance dimensions

The importance of these weaknesses and strengths are determined by the

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specific situation of governance:

1. The characteristics of the “sunset technologies” and organisations, which have to decrease their importance/market share.
2. The characteristics of the “sunrise technologies” which have to enter the market/ increase their market share.
3. The value added characteristics of the change from fossil fuel energy systems to renewable energy systems, 4. The characteristics of the goals which the electricity supply system has to fulfil.

The prominent feature in the above table is that consumer power, through ownership, supplements the overall governance structure in areas where the market and the public regulation display obvious weaknesses. The two main weaknesses of the present liberalization process with its "dualistic“ market plus public regulation” paradigm are:

- That the strongest interests in the market can capture the regulator, i.e. the Government.
- That the market degenerates into a monopolistic or oligopolistic structure.

This can be counterbalanced, if consumers are in a position to use their ownership power.

But it is important to combine this postulate with the discussion of goals and the description of the general dynamics in the electricity system.

7. The Danish energy policy and energy situation around 2000
(Specific historical situation)

As illustrated in Figure 6, it is, when designing an energy policy, necessary to have an extensive knowledge of the dynamics in the “point of departure” or historical situation. One should be able to answer the question from section 3.4. “where are we ” from an analysis dealing with the dynamics of the present institutional, technical and organisational conditions. In Chapter 5 we started this analysis by describing some characteristics linked to the paradigmatic change from fossil fuel and uranium to conservation and renewable energy technologies.

In this chapter we will deal with the specific Danish historical situation of the techno-organisational change linked to this transformation at the energy scene.

7.1 Some important characteristics of the Danish second order governance system (public regulation system)
The goals of Danish Energy Planning include a 20% reduction of greenhouse gas emissions between 1988 and 2005, and 50% before 2030. Technical scenario analyses have shown that achieving these goals requires the introduction of massive energy conservation measures, renewable energy technologies and combined heat and power systems (CHP systems). The consequence, as shown in Chapter 5, is that the necessary techniques do not “fit” into the organisational structures and economic motivation of today’s energy system, with its links to the fossil fuel organisations and techniques, and its sectored divisions of heat, power and transport organisation.

Therefore, it is not surprising that the new techniques linked to combined heat and power (CHP) and renewable energy did not develop within the existing fossil fuel based energy organisations. On the contrary, these techniques, like wind turbines and decentralised CHP plants, were introduced and implemented by grassroots organisations and local heat companies, despite strong resistance from the established energy companies. The process/strategy was that grassroots movements and local small heat cooperatives “lobbied” for the establishment of new reforms at the central level to support these new techniques and were argued for in the media. Subse-

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quently, the Parliament became inspired by these suggestions and made new laws that supported the introduction of the new techniques. After the introduction of these new reforms, the local heat and wind turbine co-operatives would then implement the techniques. The process can be named a "bottom-up –top-down-bottom action" process, which has nothing to do with a rigid central planning procedure, but is more of a procedure, by means of which the grassroots organisations and local heat companies are given the opportunity to introduce and implement innovations in the energy scene through parliamentary intervention. We call this process a process of ***innovative democracy***.

7.2 Danish Energy Policy since 1980, a case of innovative democracy

The following description contains two demonstrations of the policy evolution: Wind power development and the development of decentralised CHP (combined heat and power) systems.

7.2.1 Wind power development

The Ministerial plan is that wind power should cover around 20% of the electricity production in 2005, and 50% around 2030.

The wind power production in Denmark has developed as shown in Figure 18.

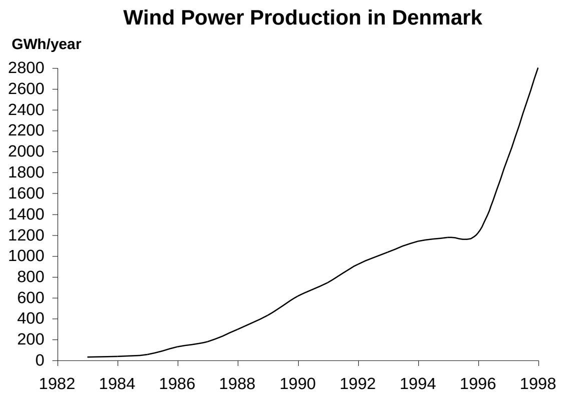

Figure 18. Wind power production in Denmark 1983-1998.

Source: Wind power Note 21. February 1999. Danish Association of Wind Turbine Manufacturers.

In 1998, which was an average year with regard to wind resources, the production of wind power constituted 9% of the total Danish electricity consumption. The proportion in 1999 was around 10% and in 2001 it will be around 15%.

Wind turbines owned by co-operatives and other private owners produce around 80% of this production. Wind turbines owned by the Utilities produce the rest, 20%.

Figure 19 shows the total production by Danish Wind Turbine manufacturers.

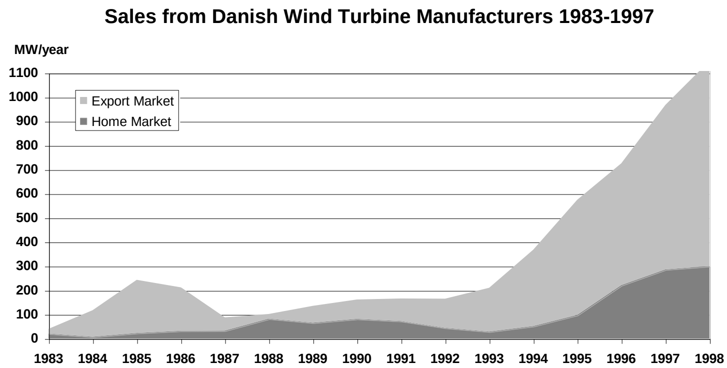

Figure 19. Total production in MW capacity by Danish Wind Turbine manufacturers 1983-1997
Source: Wind Power Note. No. 21. Feb. 1999. Danish Association of Wind Turbine Manufacturers.

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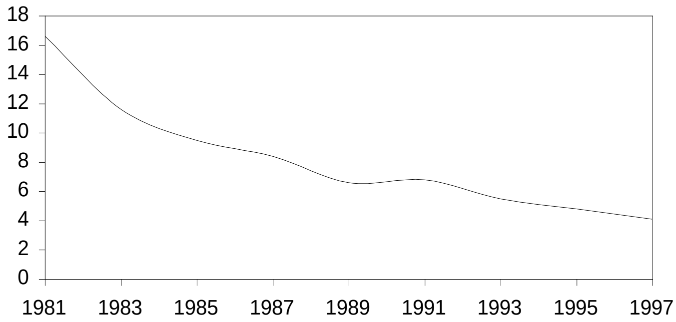

Figure 20. Wind power costs per produced kWh 1981-1997 in US C/kWh.
Source: Risø 1997. From "Ingeniøren", December 24 1998.

The wind power regulation regime has been of the type where buyers of windmills receive a fixed price from the electricity companies and a fixed public service payment for CO2-free electricity production from the Government. This is here termed a ***"Political price-/amount market"*** system**.** This system motivated the producers to lower their production prices, as they were in a situation where more windmills could be sold if the prices of wind turbines decreased. Thus, the system has been able to decrease the wind power price by around 75% within a period of 16 years, as shown in Figure 20.

The wind turbine industry did not develop out of a situation that allowed the existing monopoly market to act on its own. If anything, there was a systematic public interference in this monopoly market, breaking its "barrier to entry" institutions and opening the door for the wind power technology. By means of an array of institutional reforms, an increased freedom to enter the market was established. Examples of such reforms include the following:

The reforms and their political background can be shortly described within the wind power field. Initially there was:

- A 30% investment subsidy
- Utility obligation to buy wind power at a price equal to 85% of the price paid by consumer using a 20,000 kWh/year
- A right to produce up to 7000 kWh wind power without income tax payment

- The establishment of a public wind power test station at Risø Research Centre
- Spare capacity in the machine industry
- A motivated population

In this phase, lasting until around 1992, more than 3000 cooperative wind turbines were installed. Typically, a cooperative wind turbine has between 20 and 40 owners. This means that around 1990, there were between 100,000 and 150,000 owners of wind turbines in Denmark. Among other elements in the process, this was the result of a discussion in the organisation for renewable energy (OVE), a green grassroots organisation (NGO), which fought for this cooperative model. This model managed to secure very stable public support for wind power and it made this very vulnerable industry survive during the lean years, with very low export between 1987 and 1991.

Since 1992, the development has been supported by a steady increase in the export markets, combined with the development of larger wind turbines (600-1500 kW) and a 30-40% decrease in kWh prices.

The preconditions for the above development were:

At the political level,
- Efficient grassroots movements: especially the Organisation for Renewable Energy (OVE), and the anti nuclear movement (OOA).
- A rather open and active public debate.
- A specific balance in the Parliament, with small non-corporate parties having some power.
- A situation where the energy companies systematically worked against innovative renewable energy technologies.

At the cultural level,
- A tradition for wind power. The “modern” 200 kW Gedser Wind Turbine was closed down in the late 1960’s, so the technology was still “recent”. Prior to this, Poul La Cour had established 2-6 kW direct current electricity generating wind turbines around 1900. By 1916, there were 1300 of these turbines in Denmark (Clark, 1974). A successful tradition for consumer cooperatives followed within many sectors.

At the industrial basis level
- An industrial structure, with many small (agricultural) machine factories.
- Collaboration between the State financed Risø Test Centre and private industries.

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7.2.2 Decentralized CHP in Denmark

By around 1988, all cities in Denmark with a population above 60,000 inhabitants had combined production of electricity and heat. These CHP systems are largely coal based. Back in 1975, there had been a discussion on extending cogeneration of heat and power for the smaller cities. But the utilities, in agreement with the Ministry of Trade, which at that time was in charge of the energy area and opted for nuclear power, did not want to take this possibility into consideration.

The grassroots organisations, OVE and OOA, argued for cogeneration, as it was an alternative to nuclear power. The Utilities, the Ministry of Trade, and later, the Ministry of Energy argued that cogeneration in small cities was not technically possible, and if at all possible, it would be too expensive. Furthermore, even if it were technically possible and economically feasible, the potential was so small that it would be a waste of time to discuss it.

As late as 1988, the potential for decentralised cogeneration in Denmark was considered by the authorities and the Utilities to be, at most, 450 MW. In 1989, a new Minister of Energy came into office, and “suddenly” the next energy plan, “Energy 2000” (Ministry of Energy, 1989), showed a potential of between 1400 and 2000 MW with regard to decentralised cogeneration and industrial cogeneration.

Different institutional preconditions were established, including the utility obligation to buy electricity from cogeneration plants according to “avoided cost” pricing for electricity sold to the grid based upon the principle of long-run marginal costs (LRMC). Furthermore, a public CO2 subsidy of 1.4 US/Cent/kWh sold electricity from cogeneration plants based on natural gas, and a municipal warranty linked to financing the plants was introduced.

These institutional reforms had an enormous effect. From 1990 to 1997, the power productions from decentralised cogeneration units increased from 1% of total electricity consumption to 20%. Of these decentralised cogeneration units, 60% are organised as co-operatives owned by the residents in a small town or village. The units have between 0.5 and 5 MW electrical capacity and are mostly fueled by natural gas.

7.2.3 A turning point situation

When discussing how different regulation mechanisms work in relation to specific goals, it is not sufficient to know only the general characteristics of the technologies and organisations which should be regulated. It also is necessary to circumscribe the specific historical configuration that fosters change, as we will attempt to do.

Innovative democracy, as described above, has resulted in some remarkable developments within wind power and CHP in Denmark, with wind power supplying 15% of the total electricity consumption and more than 50% electricity coming from combined heat and power plants (CHP). Furthermore, it is a part of the official energy plan that the electricity supply from renewable energy plants, mainly wind power, should be increased to 20% before 2004. Such a large percentage of wind and heat-bound renewable energy and CHP-based electricity cannot just be sold on the electricity market at an acceptable price. Therefore, Denmark is approaching a *turning point*, where it is necessary to implement techniques that can handle the combination of a high percentage of wind and heat-bound CHP and fluctuating wind power resources.

Figure 21 shows in the "lower curve" that in the existing technical governance structure, having 10% wind power as a proportion of the total electricity production for the Danish market results in a need to export 2.8% of the total electricity production, which is more than 25% of the wind power production. The official Danish energy policy is to raise the proportion of wind power to around 20% in 2005. The "upper curve" represents a " decentralised flexible cogeneration system designed to integrate the wind power production. That type of system often has a heat pump and water heating storage system, which makes it possible to store wind power for heating purposes without excessive loss of thermodynamic efficiency. This system makes it possible to absorb all the wind power in Denmark, even when wind power supplies up to 25% of total electricity consumption. When wanting to integrate a higher percentage of wind power around the year 2010, it will be necessary to combine the heat and power sector with the transportation sector, using electric cars and hydrogen.

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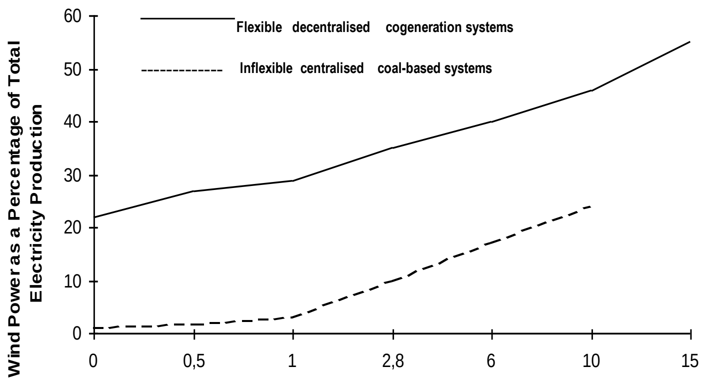

Figure 21. "Surplus Electricity" as Percentage of Total Electricity Production.
Source: "Feasibility Studies and Public Regulation in a Market Economy". F. Hvelplund and H. Lund, Aalborg University, February 1998.

At the "turning point" stage, we have two main types of possibilities:

a. A "forced" *export strategy*, where we stay at the "lower curve" and export the surplus wind power at presumably very low prices, or
b. An *integration strategy*, where we move from the "lower curve" to the "upper curve" and use the "surplus" electricity regionally in heat pumps combined with heat storage systems and, later on, for transportation purposes. This strategy enables the import and export of electricity when the prices are advantageous.

When electricity service supply systems and their second order governance systems are assessed, it is also necessary to evaluate the potential to establish the *integration strategy* in the present historical situation. As Denmark has the highest proportions of wind power and CHP production in the world, Denmark is the first country, entering the "turning point" situation and having to develop and implement the necessary technological and public regulation measures.

At the same time, all over the world, an array of reforms is introduced in the energy sector under the label of ***"liberalization".*** These reforms are normally "marketed" as fostering increased competition and decreased energy costs and consumer prices. On the renewable energy scene, the liberalization version is linked to “green certificates”, and the development of a “Green (Quota) Market for Renewable Energy” (Hvelplund, 2000).

7.2.4 Conclusion

This section examines some of the dynamics which are still built into the direct electricity supply system and are, therefore, forces that should be considered when designing energy policy in the Figure 6/16 context.

Strong resistance from the utilities - and, for many years, also from the central administration - has characterised the *political* process behind the introduction of the necessary institutional reforms. The policy has been a “bottom-up” generated policy established through considerable public pressure from grassroots movements, local heat cooperatives and some members of Parliament.

The “bottom-up” generated policy established a “top-down” policy that has given economic possibilities and freedom for actions at the grassroots level. That is why we call the policy a “bottom-up, top-down-bottom action” policy, and that is also why we call the policy innovative democracy.

The policy was not a centralist command policy. If anything, it was a policy which made it economically possible to invest in wind power and CHP plants, and where everyone wanting to invest would get subsidies and further institutional conditions without bureaucratic problems. It could be called a process of technical liberalization, where the institutional and technical “barriers” for entering, historically established by the utilities, were removed in a Parliamentary process.

Furthermore, general price rules based on the "LRMC avoided cost" principle, also in relation to payment for grid connection, ensured that the conditions for investment were general, and not dependent upon bilateral negotiations between strong utilities and weak CHP newcomers.

Therefore, an innovative technological policy, which introduces technologies which break with the economic interests and organisational inertia of the old energy companies, can only be formulated and implemented by people and institutions/organisations that have a considerable degree of independence from the old energy companies. Therefore, we believe in the necessity of keeping this “bottom-up, top-down-bottom action“ policy alive during the existing and future “turning point” conditions, to keep a process of *innovative democracy* alive.

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8. The characteristics of the Danish electricity system before the 1999 electricity reform

We are now entering the first section of the detailed system analysis, starting an analysis of the Danish energy systems with focus on the electricity supply sector. It is the first detailed study within the analytical macrostructure, as it is described and commented on in Chapter 1, Figure 1,which is shown below.

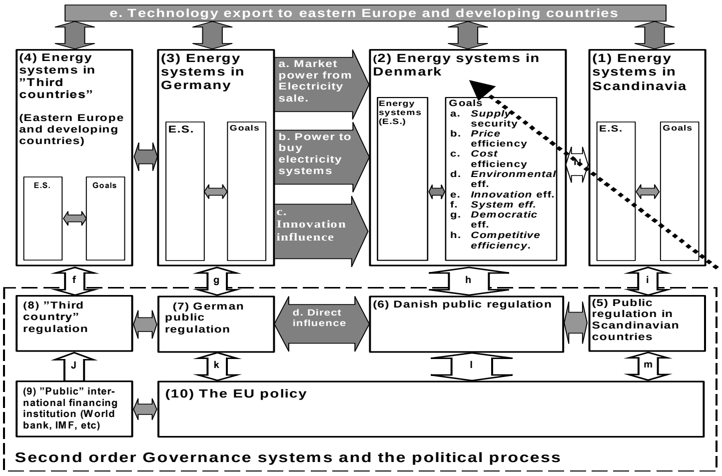

Figure 22. The analytical macro-structure.

The aim of describing the dynamics of the Danish energy systems, especially the electricity systems, is to establish a "film" of the dynamics within this "point of departure system". Within this film, any *regulatory change* or *influence from outside*, such as changes in the German energy system, is intervening. It should be recognised here that it is not possible to make well-grounded evaluations of the results of any new impacts on this "point of departure system" without having some theories regarding the dynamics of this system. It is also essential to be aware of the *methodological need* of establishing a "film" that describes the dynamics in such a way that it is adequate for the organisations of action, which in this case are the groups and organi-

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sations participating in the parliamentary processes. These groups include the parliament, economically independent grassroots groups, economically dependent organisations, the press, and the generally active and well-informed public. The *methodology* to establish this adequacy is to start the analysis at the empirical level close to the decision processes of existing organisations and conceivable coming organisations.

8.1 The organisation of the Danish Direct electricity supply system 1975-1999

The period 1975-1999 is interesting because it is a period where the Danish electricity companies have shown what they stand for by making concrete decisions where large, strategic questions were at stake regarding nuclear power, wind power, decentralised cogeneration, energy conservation, etc. The year 1999 is used in this chapter, as it was the year when a new electricity reform introduced fundamental changes in the electricity system. This reform is described and discussed in a later section.

8.1.1 Vertical integration and some remarks regarding the profit motivation

The energy world is not just a "free flying" linguistic discourse where independent persons and/or groups of persons are engaging in a peaceful, generous competition regarding the necessary future energy policy. People and groups of people are closely linked to their techno-structure and the organisational and economical interests linked to the interests of this structure. This conclusion is, among others, the result of an array of analysis at the energy area performed at Aalborg University[20]. In discussions regarding the strategy at the electricity area we never experienced any open disagreement between the 11,000 employees within the electricity companies. When the electricity companies were against decentralised cogeneration, all 11,000 employees were against it. For when the electricity companies fought most intensely against wind power, none of the employees from the electricity companies

[20] The contents and the discussion around amongst others the following publications: "Demokrati og Forandring,Energihandlingsplan 1996", Frede Hvelplund, Henrik Lund, Karl Emil Serup, Henning Mæng, Aalborg Universitetsforalg 1995.
"Offentlig regulering og Teknologisk Kursændring". Henrik Lund og Frede Hvelplund, Aalborg Universitetsforlag 1994. "Erneuerung der Energiesysteme in den neuen Bundesländern-aber wie?" Frede Hvelplund, Niels Winther Knudsen, Henrik Lund. Netzwerk Dezentrale Energie Nutzung, Potsdam 1993. Especially the 20 page arguments against the above publication from Laubag, the East German "braunkohle" company is of interest.

took a stand against this fight. When the electricity companies pleaded for building an extra 800 MW capacity in 1992, which, at that time, was already recognised as future excess capacity, none of the 11,000 employees opposed the 5 billion Dkr. investment.

But why are employees in these companies showing such political unity outwardly? One important cause is that if anybody, without asking his director beforehand, expresses a diverging opinion publicly, he or she will probably get fired instantly. And if asking the director, he or she would probably not be allowed to express their true opinion. At the same time, there were no open disagreements at the Director level in these 30 years, which is difficult to explain by just talking about common organisational culture. We believe that the discourse being established in and around electricity systems is very much dependent on the concrete economic interests built into this specific type of technology as discussed in section 5.4. Here we will apply the section 5.4. methodology to the concrete Danish situation.

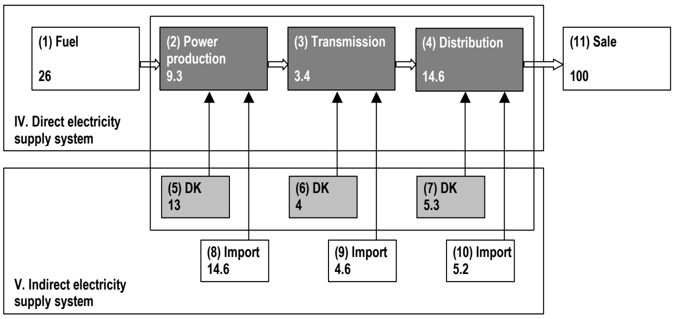

Figure 23. Value-added in a Danish coal based electricity system.
Source: Same figure as Figure 8.

The Danish direct electricity supply system was, until 2000, a system that vertically integrated activities within power production, transmission and distribution, amounting to 27% of the electricity price. Even today, it still operates in much the same way.

To sum up, it may be said that the added value resulting from the production of electricity for 100 øre (1 DKr) is allocated as follows in Table 5:

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Fuel imports	26.0 øre
Plant import (indirect electricity system)	24.4 øre
Danish plant (indirect electricity system)	22.3 øre
Danish electricity operation costs (direct electricity system)	27.3 øre
Total	100.0 øre

Table 5: Allocation of an ***electricity supply*** *of 100 øre to the consumer, on plant and operating costs, and on import to and production in Denmark.*

There is no significant integration between the *direct* and the *indirect* electricity supply system, neither of which has any significant integration with the *fuel extraction system*. The Danish direct electricity supply system includes boxes 2,3, and 4 in the above figure.

Regarding the profit dynamics within the Danish direct electricity system:
The electricity supply system has a formal direct consumer ownership (co-operatives/limited companies) in the case of 53% of the distributions companies and indirect consumer ownership (municipal ownership) for the remaining 47%. The latter form is common in the Danish cities. At the same time, it has been, until the electricity reform in 2000, a "consumer profit" system in the sense that it has not been allowed to accumulate profit for any other purposes than investment in the electricity system. If investments were not needed/justified, any surplus should be paid back to the consumers through lower prices.

The Danish direct electricity supply system, therefore, is a comparatively small system[21]. It is not likely that any Danish coal miner will protest if it is

[21] It should be explained that the increased value of the Danish electricity system represents the wages of its 11,600 employees. The employees' ability to produce the increased value is a result of the education and training they have received prior to their employment in the system. This means that these costs should be deducted from the increased value of the electricity system, because the educational system is a subcontractor of knowledge, attitudes, etc., to the electricity system. This thought may be extended, because the civil society's education and care of the labour force for the electricity system is that part of the indirect electricity system. Thus, the direct system is, in reality, only a **purpose** (electricity generation and distribution), and a **structure** (organisation of electricity supply), which organises and directs the indirect electricity generation's factors of production. In this presentation, in order to perform the analysis, it has been decided to define the wages of the employees as a part of the direct

decided not to use coal-fired plants any longer. Moreover, no strong national producers of equipment to the large power plants will put pressure on the politicians if it is decided to move away from the coal technology.

The strong resistance from the Danish electricity sector in the period 1975-1999 against renewable energy was partly due to the loss of 9.3% of the total value added linked to the production at the power plants. This 9.3% of the total value added constitutes 34% of the value added linked to the power production, transmission and distribution activities built into the electricity organisation. They were, and still are, with regard to ownership, vertically integrated from power production via transmission to distribution of electricity. The Danish electricity system consequently would lose 34% of its turnover, if independent organisations replaced capacity at the power plant level. So if the organisation were not able to absorb these new technologies, their introduction would result in a decrease in turnover and massive dismissals of employees at the power plant level.

8.1.2 Consumption, environmental effects and supply technology

The Danish electricity consumption, in 1998, was 32.5 TWh, apportioned with 19.2 TWh in the Jutland-Funen Region and 13.2 TWh in the Zealand Region. Between 1981-1998, the electricity consumption increased by 43%.

The consumption in 1998 is apportioned, according to use, as follows:

Households	29.6%
Industry	30.1%
Commercial and Service	29.8%
Agriculture and Market Gardening	8.0%
Street lighting, electrified transport, etc.	2.4%

In the ‘80s, the **resource base** for the electricity system had been coal, representing more than 95% of the fuel consumption as late as 1990. In the ‘90s, this changed in the direction of wind power and biomass and natural gas based co-generation units. In 2000, the wind power share of total electricity consumption was about 12%, versus 0.6% in 1990. And decentralised natural gas-based combined heat and power plants (CHPs) based on natural gas and biomass, were delivering 25% of the total Danish electricity consumption in 1998, versus 2% in 1990.

electricity system’s increased value.

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So within less than 10 years, the coal proportion of the Danish fuel supply has decreased from 95% to around 60%. This has happened as a consequence of a massive introduction of cogeneration plants in the small cities and larger villages. The growth in cogeneration in this period was more than 50%, so that the cogeneration share of the heat market increased from 22% to 34% from 1990 to 1998.

In terms of **environmental effect**, the SO_2 emission (corrected for import) decreased from about 200,000 tons p.a. in 1981 to about 45,000 tons in 1998.

NO_x emission has decreased from 100,000 tons p.a. in 1981 to 46,000 tons in 1998.

In the same period (1981-1994) CO_2 emissions from electricity production has decreased from 29 million tons p.a. to 23 million tons p.a..

8.1.3 The organisation of the direct electricity supply system up until 2000

With the 1999 power reform, substantial changes have been induced upon the Danish direct electricity supply system. The description below shows how this system was organised up to the reform, and also how the organisational "state of departure" was for the 1999 reforms. The organisational development naturally contains main parts of the below-described organisational structure. In order to understand the effects of the reform, one should understand the historical organisational "state of departure".

In Denmark, the **direct** electricity supply system is defined as the power, transmission and distribution system. The organisation of the direct electricity supply system is divided into two main regions; ELKRAFT, which is a co-operation covering the area of the island of Zealand and neighbouring islands, and ELSAM, which is a co-operation covering the area of the Jutland peninsula, the island of Funen and neighbouring islands.

The electricity system is, in principle, hierarchic ("bottom up") which has a **formal direct consumer ownership** (co-operatives/limited companies), in the case of 53% of the distribution companies, and **indirect consumer ownership** owned by municipalities for the remaining 47%.

The latter form is common in the cities. The "bottom" is the consumers delegate power to hierarchical power systems. This power is controlled by open information and election procedures, where the consumers elect the board of directors at the different levels of the hierarchy.

In the ELKRAFT area only a minority of the distribution companies are co-operatives with direct consumer ownership, municipal ownership is the rule.

In the ELSAM area 30 out of 81 distribution companies are owned by the municipalities, and the remaining 51 companies have direct consumer ownership via a cooperative organisation[22]. The 51 distribution companies organised in direct consumer ownership accounts for 67% of the electricity sale in the Jutland-Funen area.

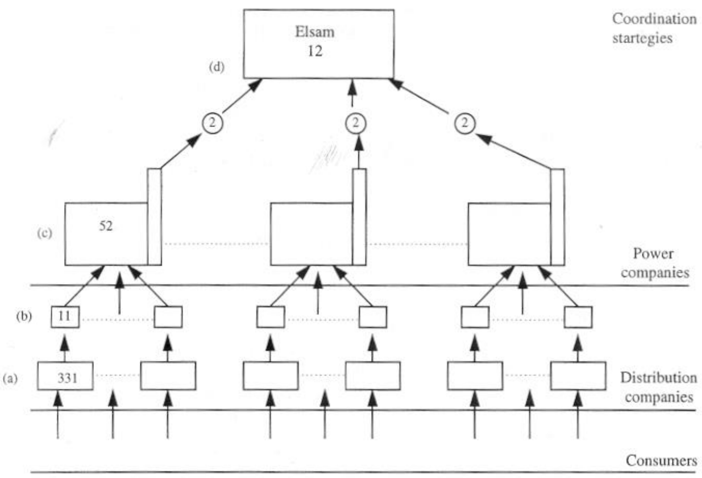

Figure 24. The organisation of the Jutland-Funen electrical power system.

The Jutland-Funen power system has six power companies, each owned by the distribution companies in their region. The largest, Midtkraft, produces 22%, and the smallest, Skærbækværket, 9% of the Jutland-Funen electricity sale. The 81 distribution companies in Jutland-Funen, each have their area monopoly,the largest selling 700 GWh/year, and the smallest, an island, 1 GWh/year.

[22] This includes 10 distribution companies organised as private foundations with consumer election of representatives and board of directors.

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Regarding the distribution companies owned by the municipalities, the members of the Town Council elect the representatives. In the consumer owned cooperative distribution companies; the consumers elect their representatives in the distribution companies (a). These representatives elect their board of directors (b). This board of directors elects their representatives for their power plant company (c). From each power plant the director and the deputy director are automatically members of the power plant association for Jutland-Funen, ELSAM (d). ELSAM is the co-ordination unit and the organisation, which elaborates the political strategy for the electricity system in Jutland-Funen.

The Danish electricity system is usually described as a non-profit system, because the Electricity Supply Statute does not permit the electricity companies to build up a surplus, or to use any surplus for non-energy purposes. An accumulated surplus in any year must be returned to the consumers by means of lower prices in the following year. However, the system is profit driven, inasmuch as it is owned and administered by the consumers, who receive the reward from its cost effectiveness. From this point of view, we find it better to describe the Danish electricity system as a **consumer profit** system.

To a great extent the electricity system is **self-financing**, as the consumers pay in advance via the electricity prices in a five-year period before a new power plant is ready for production. Due to the fact that the electricity system is an old, well-established system, it is so well consolidated that debt is limited to the value of its coal stocks, and the **power plants and transmission and distribution lines** are without debt.

8.1.4 The dynamics of the Danish direct electricity supply system

The most interesting questions for our purposes is the dynamics of the electricity system with regard to capability of change, inherent growth dynamics, cost regulation and abilities to influence the Parliamentary processes.

As shown above the Danish direct[23] electricity system is a relatively **small system** providing only about 27% of the added value, which is represented in the price of the electricity[24]. Coordination within this system is not regulated by conditions of a traditional competitive market[25]. In this part of the direct elec-

[23] Consisting of power generation, transmission and distribution.

[24] The German system, e.g. RWE Energie, which owns lignite mines and the subcontractors who deliver the power plant, organise 60-80% of the added value in the final price for the electricity.

[25] There is no competition in the sense that a dissatisfied customer of an ineffective and expensive distribution company can choose another supplier. There is competition in the sense that the dissatisfied customer can compare the price of electricity from the

tricity system, the Danish system is **vertically integrated** and influenced by agreements made on the basis of a network of reciprocal ownership relationships.

Historically, it has been a very democratic organisation. Democratic election to the bodies responsible for transformer stations and distribution lines ensure consumer control. At the beginning of this development, where the plants were small, this control functioned well. The situation has now changed. This is the result of the development of the technical organisation towards larger and larger power plants and larger electricity transmission system. This development has resulted in decreased consumer control and increased control at the director level in the power companies. The organisation's combination of openness with regard to pricing, the system of profit repayment to the consumers and consumer ownership and management appear to ensure a high degree of cost effectiveness in the electricity system.

The hierarchic structure of the system, with a series of indirect elections, and in combination with the dominance of the power interests at the top of the system, results in a technological conservatism, which is bound to a certain centralist and supply orientated paradigm.

The fact that there is no lobbying from coal miners and stock holders, and that the electricity system is very consolidated, makes it possible, although still difficult, to establish public regulation regimes when necessary against the interests of the power companies.

8.1.5 The Danish direct electricity system and the capability for technology change (green innovation)

The consumer representatives at the ELSAM/ELKRAFT level are not in harmony with the citizens' desire for a more environmentally favourable electricity production. In terms of ability to incorporate radically new technologies, the organisation is far from being competitive. Minority interests are excluded in the series of indirect elections. Because new ideas are almost always minority ideas, they do not find a way through to ELSAM`s board of directors. Furthermore, ELSAM's board comprises the chairman, vice-chairman and managing director for the seven power plants and thus represents a certain technology, e.g. centralised power plants. In principle, new

distribution company with the corresponding price in another company. Thereafter, the dissatisfied customer, as one of the owners of the electricity system, can put pressure on the consumer representative, who has the possibility of changing the management of the company.

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ideas may be pressed through the hierarchy of the electricity system, but other channels are quicker and easier to use. Thus, the democratic channels of the electricity system are bypassed by a combination of popular movements and the political channels through district, regional and national public authorities and institutions.

In a situation where there is a need for radical change of technological direction, the form of organisation of the power plants creates conflicts in relation to the rest of society. Their organisation is geared towards the efficiency norms of the 1950s and 1960s concepts of "expansion and centralisation". But times have since changed. Norms of today are "cost reductions" and "decentralisation". The power companies have difficulties in developing new ideas. Therefore, there is a conflict in relation to parliamentary democracy, which still has this capability, to a certain degree.

It is important to notice the following features:

(1) The elected board of directors of ELSAM had a preference for large centralised power plants (currently coal plants). This is the case because the board consisted of the elected director and deputy director in each of the six large coal-based power plants. There was no independent administration linked to the elected board of directors.
(2) Furthermore, the administrative directors of these companies had the right to meet (but not to vote) at the four to six committee meetings every year. There was no independent administration linked to the elected board of directors.
(3) A set of indirect election procedures squeezed out, and in the unbroken consumer ownership system still squeeze out, any minority group, and new technology is always a minority at the initial stages of its development.
(4) Until 1999, there was a high degree of openness with regard to accountancy and tariff information. Every year information regarding these matters was published, and generally open for the public. Information regarding cost structure was generally available before the 1999 reform, but is now available to a much lesser degree after the reform. Exact information regarding the electricity prices was, until the 1999 reform, available at the power plant as well as distribution level for the vast majority of consumer groups. However, since the reform there is no clear public available price statistics regarding the prices at the power plant level. Until the 1999 reform, any consumer could see what other consumer groups and consumers

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Some of the owners of the electricity system can put pressure on their consumer representative, who has the possibility of changing the management of the company.

in there own area and in other areas paid for electricity. This openness with regard to costs and prices in combination with consumer ownership and public control, until 1999, seem to have caused a rather high cost-efficiency in the Danish electricity system. As we shall see later, Denmark has the lowest electricity prices in the EU after Sweden and Finland. For smaller industries and large farms, the prices are even lower than the Swedish and Finish electricity prices.

(5) The Danish electricity system is consumer-owned, and it is stated by law that any payment for electricity has to be recycled to the electricity consumers. This system ensures that the Danish electricity system has a very low debt ratio, amounting to less than 5% of the construction cost value of all assets.

(6) There was no taxation on power company profit because by Statute power companies must pay back profit to the consumers. Also, a capital tax is not levied on company assets, which are calculated to be approximately 40 billion DKr. No concession royalties are levied.

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(1)+(2)+(3) results in **an electricity organisation, which, in the period 1975-1999, was very conservative concerning technological changes**. The conserved technology is a centralised coal-based system. Therefore, it is no wonder that this type of organisation has systematically worked against the introduction of decentralised cogeneration plants since 1975.

(4)+(5)+(6) resulted in an organisation, which was rather cost efficient and governable due to relative openness and financial ability to survive changes.

All these characteristics are important when analysing this organisation as a part of a process of change. One could say that the 1975-1999 Danish electricity organisation could not change itself but was able to survive in a process of change.

Seen in relation to the goal hierarchy illustrated in Figure 6, and discussed in Chapter 5. This section brings the following conclusion:

8.1.6 The direct electricity supply systems motivation for increasing the electricity consumption

a) *Expansion on account of the dynamics of co-ordination*

In the power companies there are large groups of employees whose employment is dependent on the construction of new plants and on the future of the power companies. Every one of these companies is represented in ELSAM's board of directors and is protected from abandonment by a series of agreements. The finely balanced system of cooperation, with complicated volume

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and price agreements on mutual power delivery, functions without a market competition. It is a mutual support system, where the individual Power Company cannot "go bankrupt". Within ELSAM, all of the six power companies have a desire for plant extension. The costs are mutual, but they cannot all be extended at the same time. In 1991, Vestkraft Power Generation Capacity (PGC) in Esbjerg had just been extended, just after Funen PGC in Odense, the following on the list being Skærbæk PGC and Nordkraft PGC.

Expansion, in the form of more power plants, was a necessity in the former ELSAM organisation. The proverb "the horse bites when the crib is empty" is very relevant in an organisation of this type.

ELSAM currently wishes to implement a long-term plan for a high-tension grid for the entire Jutland-Funen area. The aim of this network is to provide a second relief of high-tension supplies to all parts of the area. The largest capacity is now 400 kV, which ELSAM describes as the power motorway. The area already has several supply routes, but only at 150 kV. When the more powerful grid is completed, ELSAM will implement a more effective daily re-organisation, in which they will own the 400 kV network, while the 150 kV network will be transferred to the ownership of the individual power companies. At the present time, only four or five out of a total of 15 sections require completion in order for the high-tension grid to be accomplished. The section between Aalborg and Aarhus is one of the remaining.

ELKRAFT has similar plans. On Zealand the expansion is concentrated on one large power company, SJÆLLAND PC, which supplies 85% of the generated power within the area. The recent expansions have resulted in an agreement for 350 MW to be sold to the former East German Electricity Company, VEAG, in the period 1996-2006.

b) *Expansion on account of the dynamics in the allocation of internal costs*
The electricity systems regulation on capital transference is favourable towards electricity distribution companies with an expanding consumption. The old solidarity principle from the initial electrification period, when those who had been provided for were prepared to pay for the continued electrification, is still applicable in this regulation. The distribution companies, which make an effort to save electricity, did not pay less in capital transference levies per kWh to a new power plant than a distribution company which did nothing for electricity saving.

c) *Expansion on account of the dynamics in the allocation of external costs*
The consumer who economises on electricity consumption paid the same in capital transference levies per kWh to a new power plant as a consumer who did nothing towards electricity saving and, thus, increased the need for a new power plant.

Recent expansions have resulted in an agreement for 350 MW to be sold to the former East German Electricity Company, VEAG, in the period 1996-2006.

d) *Expansion on account of the dynamics in the allocation of internal costs*
The electricity systems regulation on capital transference is favourable towards electricity distribution companies with an expanding consumption. The old solidarity principle from the initial electrification period, when those who had been provided for were prepared to pay for the continued electrification, still applies in this regulation. The distribution companies, which make an effort to save electricity, did not pay less in capital transference levies per kWh to a new power plant than a distribution company which did nothing for electricity saving.

e) *Expansion on account of the dynamics in the allocation of external costs*
The consumer who economises on electricity consumption paid the same in capital transference levies per kWh to a new power plant, as a consumer who did nothing towards electricity saving and, thus, increased the need for a new power plant.

f) *Expansion on account of democratic influence*
The democratic influence at power plant level and ELSAM level was dependent on the amount of used kWh electricity, and still is, after the 1999 reform and changes in the electricity organisation (See chapter x). This means, that decreased electricity consumption in a distribution company results in decreased influence at the power plant and ELSAM level.

8.1.7 The Danish direct electricity supply systems cost and price efficiency

As the Danish direct electricity supply system is a consumer owned system with a “sort of monopoly”[26], there has been very tough ideological pressure upon the system from the present “neoliberal ideological movement”. It has al-

[26] It is theoretically not adequate to call a well functioning consumer owned system a monopoly system, as any monopoly surplus will be paid back to the consumers. The ”monopoly effects” might nevertheless exist if control over the system is lost and too many/ ”lazy”/ or expensive employees exist. This does not seem to be the case in the Danish consumer owned electricity supply system.

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most become a common prejudice that an area monopoly, although owned by consumers, will or might become expensive and lazy. Therefore, it has been difficult to acknowledge that the Danish electricity supply system has had the lowest electricity prices in the EU for the last decades.

The following discussion will be divided between an analysis of the cost performance and the price efficiency performance in the Danish system. In this case, costs and prices are the same, because of the "consumer profit" organisation of the system. But costs could naturally rise, due to what economists would see as a lack of *electricity* market[27] competition. Let us take a look at the cost performance of the Danish system.

Cost performance of the Danish Electricity Supply System from 1980-2000

Year	**1980**	**1990**	**1998**	**Productivity change from 1980-1998 in %**
Sale in DK	22 TWh	28.6 TWh	32.6 TWh	+ 48.2 %
Employees in distribution	5996	5405	5269	- 12.1%
Employees in production	4957	6384	4781	- 3.6%
Total number of employees	10953	11789	10050	- 9%
Sale per employee in distribution GWh	3670	5290	6190	**+68.7%**
Sale per employee in production GWh	4440	4480	6820	**+53.6%**
Total sale per employee in GWh	2010	2430	3240	**+61.2%**

Table 6. Developments of labour productivity in the Danish electricity supply system 1980-1998.

The 1980-1998 period was a period during which the Danish electricity supply system was consumer owned and non-profit oriented, or, to be more exact, a consumer profit system. During this time, the total number of employees decreased by 9%, whereas the production increased by 48.2%. The total labour

27 By *electricity* market competition we mean price competition on a market where different suppliers of electricity offer their electricity services to the consumers, who can then buy wherever they get the best offer.

productivity increased by 61.2 %. The increase in labour productivity has been especially high since 1990.

The above development is an indication of cost sensitivity and cost efficiency in the Danish electricity system. However, it does not tell anything about the capital cost efficiency of the Danish system, a question that we have not examined in depth here. Some incidents indicate capital inefficiency in the Danish electricity system, especially with regard to the power plant capacity, where the excess capacity was built in the late nineties. Meanwhile it is difficult to say whether this event was built as a consequence of the specific consumer ownership construction described above. It happened during a time of widespread knowledge between power company administrators, meaning that a sort of competition and liberalization would be introduced at the end of the century.

So the capacity expansion in the late nineties might very well have been a sort of free expansion *paid by the consumers on a monopoly market* just before the doors of competition were opened when this possibility no longer would exists. In fact, we do not know whether the Danish consumer-owned model resulted in capital inefficiency. What we do know is that a combination of the Danish consumer ownership model and a ”near liberalization” results in the establishment of excess capacity and capital inefficiency.

The distinction between cost and price efficiency is often forgotten. It should be emphasised that it is easily possible that an electricity system can be cost efficient and price inefficient at the same time. It simply evolves when the owners or administrators of a company in a monopoly or an oligopolistic situation exploits this situation and collects a monopoly profit.

Here, we deal with two levels, namely (a) price level efficiency, and (b) price distribution efficiency, both dealing with the character of price difference between various consumer groups.

8.1.8. Price level efficiency

The British experience

In Tables 7 and 8, we compare the electricity price development for different consumer groups in the UK and Denmark during the 1990-1997 period. In the UK, privatisation started in 1990, where distribution and power companies were sold on the stock market. 60% of the stocks in power plants were sold by 1/3/1991, and the rest was sold in 1995. American holding companies own six out of the 12 distribution companies, which still are monopoly firms in their areas. (For a further description of the UK power reform see (Thomas 1997)).

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	1990		1993		1994		1995		1997	
kWh/year	DK	UK	DK	UK	DK	UK	DK	UK	DK	UK
30000	5,99	8,83	5,67	10,2	5,68	10,3	5,53	9,55	5,14	11,2
50000	5,92	8,74	5,59	9,94	5,6	10,1	5,45	9,32	5,06	10,5
160000	5,65	9,62	5,37	11,0	5,34	11,3	5,31	7,8	4,92	8,63
1,25 mill.	5,43	7,26	5,13	7,82	5,14	7,97	5,01	6,72	4,63	6,65
2 mill.	4,75	6,34	5,01	6,84	5,06	6,29	4,97	6,0	4,63	5,93
10 mill.	4,72	6,31	4,93	5,39	5,0	5,56	4,88	5,69	4,51	5.52
24 mill.	4,38	5,67	4,64	5,31	4,67	4,98	4,69	5,25	4,22	

Table 7: British and Danish electricity prices for industry and excluding. taxes in ECU pro 100kWh for different consumer groups. (As of 1/7/1997, the ECU equaled 7.54 Danish Crowns).
Source: Electricity prices 1990-1995, Eurostat and Statistics in focus, Energy and Industry, 1997 nr. 28 Eurostat.

Comments: *All figures are excluding Value Added Tax and other taxes. The UK is represented here by the figures for London. In Birmingham the development has been almost the same. The statistics for Leeds and Glasgow are incomplete, but where there are figures, they indicate the same development as in London and Birmingham. The Danish numbers represent an average of the prices in SEAS, København, NESA, EFLA, Herning, Arke, ENV, KOE, MSE.*

It should also be emphasised that, all things being equal, one would have expected a decrease in the difference between Danish and UK electricity prices due to the fact that the UK producers in the period changed away for expensive UK coal contracts, and in 1997 had considerably lower fuel prices than they had in 1990. For the whole period Denmark bought coal at the world market, and therefore had no gains due to falling fuel prices.

	Denmark			UK		
Consumption kWh/year	1990	1997	**Growth in % 1990-1997**	1990	1997	**Growth in % 1990-1997**
30000	45,2	8,8	- 14	6,6	84,6	+27
50000	44,6	8,1	- 15	5,9	79,0	+19,9
160000	42,6	7,1	- 13	2,5	65,1	- 10
1,25 mill.	40,9	4,9	-14,7	4,7	50,1	- 8,4
2 mill.	35,8	4,9	- 2,5	7,8	44,7	- 6,5
10 mill.	35,6	4,0	- 4,5	7,6	41,6	- 12,5
24 mill.	32,7	1,8	- 3,7	2,7	39,5[28]	- 7,5

Table 8. Price development in UK and Denmark in øre/kWh for the 1990-1997 period

Regarding comparative price development in the privatised UK system and the consumer owned non-profit/consumer profit system, the following can be concluded:

a. UK prices were around 45% higher than the Danish prices in 1990. In 1997, UK prices were around 67% higher (average for consumer groups with an annual consumption of 10 mil. KWh/year and less).
b. In the UK, the price difference between small and large consumers has increased since the 1990 privatisation. The opposite has happened in Denmark.
   In 1990, small firms and farms paid 50% more per kWh in the UK than in Denmark.
   In 1997, they paid 100% more than in Denmark.
c. In the UK, even large consumers, with an annual consumption of 24 mil. KWh or more, paid 24% higher price for electricity than in Denmark.

The development in other EU countries is illustrated in Table 9 below.

[28] 1995 numbers are used here since there are no 1997 numbers from Eurostat.

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Country	Denmark	Finland	Sweden	UK	France	Belgium	Germany
(1) Payment in DKK 160.000 kWh/year consumer	59200	66400	75520	104000	100800	141120	148960
Payment, øre/kWh	**37**	**41,5**	**47,2**	**65**	**63**	**88,2**	**93,1**

Table 9. 1997 electricity prices per kWh excluding taxes in some EU countries.
Source: Statistic in Focus NR. 28, Eurostat 1997.

As can be seen from this table, a typical small firm or large farm, would have an annual bill which would be higher by 76% in the liberalized UK, by 70,5% in France and by 138% in Germany, than under Danish price conditions.

Regarding the cost and price efficiency of the Danish Electricity Supply System, we can conclude that price and cost data indicate that its performance is far more convincing than most other electricity systems, and that it has performed better, than the UK system, since its privatisation in 1990.

8.1.9. Price distribution efficiency

Table 10 shows the difference between the Danish- and some European countries "price spread performance". The table shows a very distinct difference, where Denmark has a far more "flat" price structure, than the four countries around Denmark and the UK.

	Finland	Sweden	Norway	Germany	UK	Denmark
Percentage for which the kWh price is higher for *a 30000 kWh/year-* than for a *10 mill. kWh /year* consumer	**47.4**	**78.8**	**46.5**	**101**	**103**	**14**

Table 10. Difference in kWh price between 30,000 kWh/year- and 10 mill. kWh/year consumer.
Source: Eurostat: Statistics in focus. Energy and Industry, nr. 36, 1996 and nr. 8 and 28 1997.
Average between 1/7 1996, 1/1 1997 and 1/7 1997 prices. With regard to the UK numbers, the source is Statistics in focus, Energy and Industry, 1997, Eurostat.

We have analysed the "price spread" development from 1982-1992 for all Danish electricity distribution companies. This analysis shows a very vivid price development between the different consumer groups from year to year in the individual distribution company, and large differences from company to company. In Denmark there are 111 distribution companies, of which 46 have municipal ownership, and the rest different forms of co-operative consumer ownership. A few examples from our analysis will illustrate this.

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Example 1: A consumer-owned electricity distribution cooperative in Bjerringbro selling 97 GWh electricity in 1999.

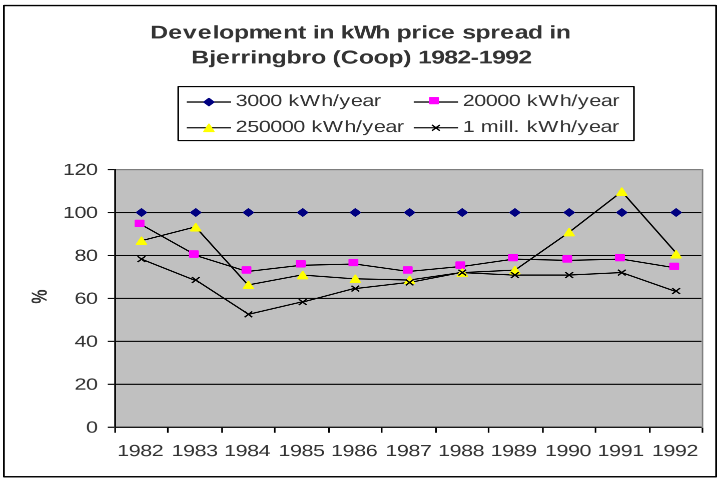

Figure 25. Price spread development in Bjerringbro consumer owned electricity distribution company.

Source: Calculated on the base of information from 10 volumes of "Elforsyningens tariffer og elpriser". The volumes from 1983-1993. Danske elværkers forening.(The figures shows the average kWh price paid by a consumer. Calculated as the bill paid for electricity divided by the number of kWh bought one year.)

From the figure we can see that there is an ongoing "price communication"[29] within the company. In 1987, a 250,000 kWh/year consumer paid around 70% of the price pr. kWh of a 3000 kWh/year consumer. In 1991, they paid 105%. In 1982, a 1 mill. kWh/year consumer paid 80% of the average kWh price of a 3000 kWh/year consumer. In 1984, they paid only 55%. In addition, the price structure is very flat. The difference between the kWh price for a 20,000 kWh/year consumer and a 1 mill. kWh/year consumer is less than 10% on average in the period.

[29] It would be a very interesting research process to analyse the processes of price formations in this and other firms. Regrettably, there has been no time for this here.

Example 2: A consumer owned cooperative, "Himmerlands electricity supply" electricity distribution company selling 797 GWh electricity in 1999.

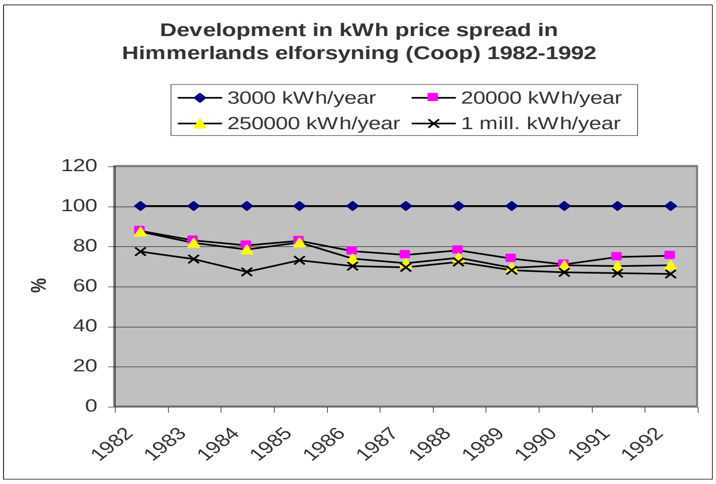

Figure 26. Price spread development in Himmerland consumer owned electricity distribution company.
Source: As Figure 25.

The general price spread development in this company is characterised by varying from year to year when compared with the price spread development in Bjerringbro in Figure 25. The company displays a general tendency of relative kWh price increase for the 3000 kWh/year consumer.

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Example 3: A municipally owned electricity distribution company in Århus (the second largest Danish city) selling 680 GWh electricity in 1999.

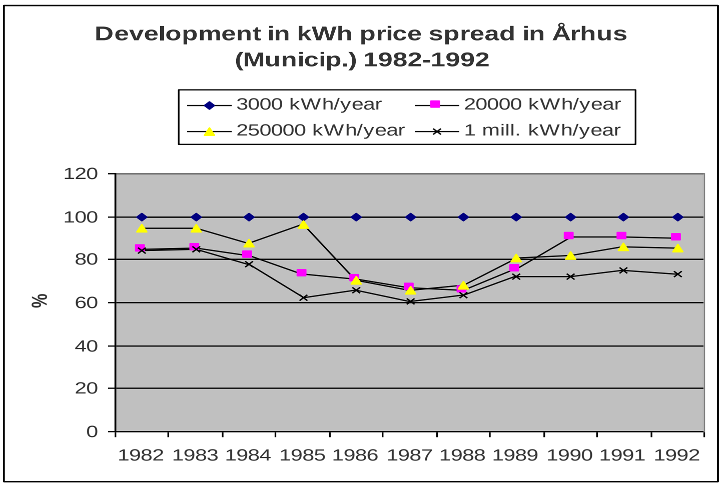

Figure 27: Price development in Århus municipal owned electricity distribution company.
Source: As Figure 25.

The figure also shows a lively development in the relative prices, although the differences between the kWh price at a 20,000 kWh/year consumer and a 1 mill. kWh/year consumer is relatively stable over the period, with the year 1985 as an exception. The period in the late eighties had a mayor for the energy area, who belonged to a green and left wing party[30], and secured a decrease the fixed price share for household consumers in 1989. Consequently, the difference between the average price of a 3000 kWh/year consumer and the other consumers decreased, as it is seen at the figure.

[30] The decision regarding decreasing the fixed share of the electricity price was met with severe resistance from the electricity company's top administrators. The Mayor, Lone Hindø, organised an advisory "backing group", which gave her specialist support, in her discussion with her own administration (I was one of the members of this group).

Example 4: A municipally owned electricity distribution company in Copenhagen, selling 2.7 TWh electricity in 1999.

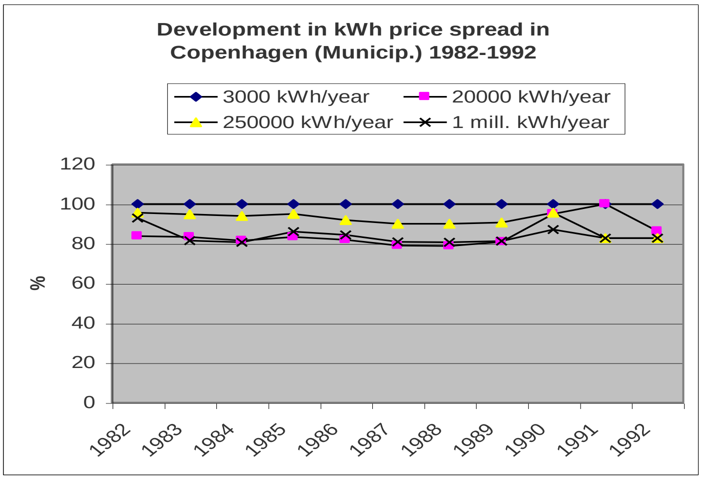

Figure 28. Price spread development in Copenhagen municipal electricity distribution company.
Source: As **F**igure 25.

Copenhagen is characterised by a comparatively very small price spread between small and larger consumers. This historically has given problems with the association of Danish industries. When the "flat" price structure has been maintained during so many years, it is reasonable to believe, that it is caused by the fact, that household consumers makes up the vast majority of voters.

What can then be learned from the above analysis of the electricity price spread development?

During the periods, there has been some state control of prices, through the Government's "Electricity price committee". But this committee has accept-

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ed a very decentralised price development with regard to the "price spread" question.

As mentioned, the Danish electricity system is by law a "non profit", or better expressed, "consumer profit" system, where any surplus in year 1 is paid back to the consumers in year 2 by lowering the prices. The low price spread in the Danish system is probably, amongst others, caused by this incitement structure which does not further any profit oriented pricing policy. It has neither been necessary nor profitable to levy high prices upon consumer groups, with no easy accessible alternatives (low price elasticity), and low prices on consumer groups with accessible alternatives (high price elasticity). There simply has not been any motivation for cashing in on the monopoly position.

In a shareholder profit oriented system, the optimal price policy would be to take advantage of the different price elasticity of the different consumer groups, thereby also taking advantage of the position as area monopoly. In such a system, the price policy is characterised by a combination of a relatively high capacity payment and a considerable price spread.

Regarding the concrete price spread development, as described above, we will emphasise the following interesting comments and observations:
- The price structure in the cooperatively owned electricity companies will be basically decided upon by the democratically elected board of directors, and reflect power structure and culture of conduct in this forum. As the vast majority of representatives in these groups consists of farmers, small industrialists, common household consumers, etc., it is not surprising, that these cooperatives will end up with a very flat price structure. There, though, is a tendency to establish a price structure with an increased fixed component for common household consumers, resulting in an increased price spread between this group and the other groups.

- The price spread varies considerably from period to period within the individual electricity distribution company. Not surprisingly, there seems to be a political competition between the different consumer groups.
- The price spread development also varies clearly from company to company. So the price spread development is an individual business linked to the concrete culture and power relationship between the consumers in the individual company.
- It is a general tendency in the material, that the large consumers, and to some extent the household consumers, in the consumer owned cooperatives, seem to be losing the price battle. (On the other hand they are re-

gaining what is lost by electricity prices, which are, in a European comparison, very low.)

It is interesting to combine the above price discussion with the description of the value-added distribution in the electricity supply system.
A distribution company is-and will remain as long as distribution networks are used- in a technical monopoly situation with regard to the supply of "grid services". This is the case all over the world, even in the most "liberalized systems". *The grid service remains a monopoly service*. The only present technologies that compete with this monopoly are different types of electricity conservation technologies.

This has as the consequence that a price market cannot give the consumers any control over the grid service. One or another type of political control has to exert this task. One then can choose between third party political control via the state or local government and/or one can exert the control directly by means of consumer ownership of the "monopoly" parts of the electricity system value-added chain. In a system with "third party" state control of the monopoly service, it is a risk that the state could be captured by the largest industrialist and allow very low prices for these groups of consumers. In a consumer owned system with price transparency, it seems possible to establish a pricing process, where the controller is not captured by any minority group of large consumers. The "pricing power" is, in general, distributed according to number of voters and not according to number of kWh used.

But how can this good cost, price level and price distribution performance be accounted for?

8.1.10 Conclusion regarding costs, prices and consumer ownership
The organisational setting assuring a high cost and price efficiency in the Danish electricity system consists of:
(a) Consumer ownership, and elected representatives, who are motivated to keep costs and prices low.
(b) Openness of information (see “communication power” in Figure 17), that makes it possible to compare prices locally and between different regional electricity distribution companies.
(c) A non-profit legislation that hinders the direct use of money from the electricity consumers for other purposes.
(d) A relatively democratic public regulation and a free press.
(e) It should furthermore be emphasised that in a shareholder owned “liberalized” system, the price includes a profit to the shareholders, which in the

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consumer owned system goes back to the consumers. This mechanism is described in Figure 29.

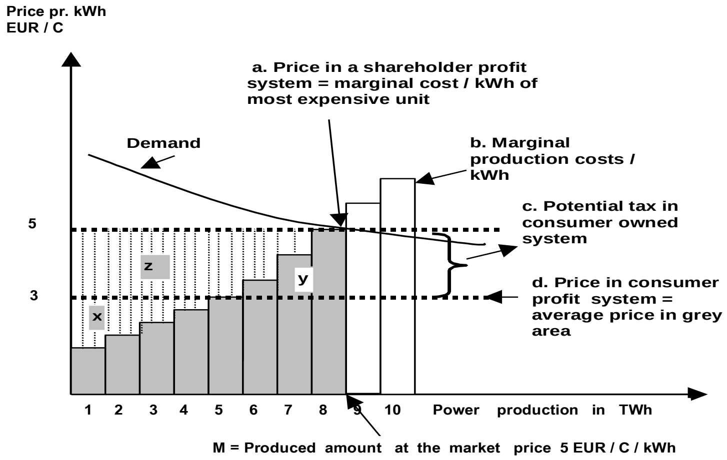

Figure 29. Consumer price in a shareholder profit system and in a consumer owned "consumer profit" system .

The column figure represents the marginal costs of power production. The produced amount and price in a shareholder profit system is determined, where this figure meets the consumer demand curve. In this case, the production is 8 TWh/ year and the price is 5 EUR/C/kWh. The profit to the shareholders then will be the area with the vertical dotted lines, z plus x.

If the same amount is produced in a consumer owned consumer profit system, this area z + x is paid back to the consumers. The normal way of doing this is by lowering the price to the average cost level[31], which in this case will be 3 EUR/ C/kWh.

[31] This, meanwhile, entails the problem of having lower prices than marginal costs. This problem can be solved in many different ways. One is, that the government absorbs the difference between average cost pricing and marginal production costs by levying a tax on electricity as shown in the figure by *"c. Potential tax in a consumer owned system"*. Another way of keeping the prices sufficiently high in a consumer owned system is by having a low payment for capacity, and a relatively high payment for actual kWh consumption.

In the Danish consumer owned system, a combination of taxes and, compared to other countries, a very low capacity payment has kept the actual price paid by the consumer higher than average production costs, and increasingly closer to marginal production costs. It should, however, be underlined that the Danish electricity prices has, in several periods, been lower than long-term marginal production costs in a coal-based electricity system. It, therefore, has also been proposed to elevate the electricity prices up to the level of long term marginal costs by putting higher taxes upon the electricity system. In that way, the price will be equal to marginal production costs (5 EUR/C/kWh) and the Government is absorbing the profit, which, in a shareholder owned system, is gained by the shareholders. In the Danish case, this has given a financial background of giving subsidies to the development of new renewable energy technologies.

In a **shareholder profit dividend system**, the interest is in profit maximising, by means of a combination of high ***electricity prices and low costs.***

The idea in a shareholder owned system is that firms must compete against each other for shareholder capital. Because of this competition, capital seeks the activities that provide the largest surplus. The characteristic of this system is the payment of dividends to shareholders for their investment; the secondary effect is that the shareholders have an interest in a large profit. This goal is achieved by trying to ***get as high prices and as low costs as possible***. Therefore, a shareholder owned system might have an interest in outdoing, bribing, or lobbying against the regulator in order to achieve a monopoly and hinder public price control. It is this mechanism which operates in Germany, where the electricity companies pay concession royalties to local regional and district authorities, and where these authorities continually make alliances with the electricity companies, in order to avoid greater competition on the market[32]. So far, these alliances have been successful, inasmuch as they have successfully prevented many attempts to establish greater competition on the German electricity market.

In a ***consumer owned and consumer shared profit system***, there is an interest in ***low costs and low electricity prices*** if the democracy in the consumer ownership model is strong enough to control the bureaucracy/technocrats of the companies. There will be no interest in higher electricity prices for owners-

[32] See, for instance: "Energiekonsensusrunde Ost" of 31/31996, where the power companies obtain the endorsement of the "Bundeswirtschaft Ministerium" to use cross-subsidiation in order to expand the monopoly. The text is available at the Bundes Ministerium für Wirtschaft und Industrie in Bonn.

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consumers, as opposed to the interest in a shareholder-organised enterprise. Therefore, there will be no strong interest in cheating or "bribing" the public price regulator.

On the other hand, in a consumer owned system, consumer control could be so weak that an expensive bureaucracy might counterbalance low electricity prices. To avoid this, alternative control mechanisms of market competition between different power suppliers have to be introduced[33]. In the Danish case this alternative control mechanism has been successfully implemented as a ***combination of openness about tariffs and sales conditions, and an effective control by means of the consumer-elected representatives.***

Both forms of organisation will continuously attempt, in their own way, to influence the economic framework for their own benefit. This way of functioning, in relation to societal aims, is completely dependent on the exact nature of the relationship between the electricity system and the existing political system. Consumer ownership might only function efficiently if placed in the right context supervised by a legislation demanding openness of information for the public, and establishing strong democratic mechanisms within the electricity companies. But given the "optimal" regulation context around the organisation, the consumer ownership model can probably be controlled with considerably lower transaction costs than private companies within a techno-structure similar to that of the electricity supply type as described in Figures 8 and 9. These features seem to ensure a cost and price efficiency which appears to be even more effective than the cost and price regulation in a system where the consumer can select between different power producers. So cost and price regulation in the Danish system operates by means of openness[34] about and publication of consumer prices and costs in combination with the consumer representatives' interest in keeping costs low. In this area, the con-

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[33] It must be kept in mind that "liberalized" systems, like those in Sweden and the United Kingdom, do not have many independent power suppliers. Therefore they cannot be called liberalized systems with any market as such or with conditions close to what is called 'perfect competition' in the economic theory sense. It can be argued that the Danish regulation regime is closer to perfect market conditions, as the regulator systematically removes the "barriers to entry" for new technologies. The result of this policy is that the production from decentralized cogeneration plants and windmills has grown from around 4% in 1990 to 27% in 1996.

[34] It is interesting, in this connection, that the Danish electricity system is based on coordination, plus a high degree of openness of information. The English system, following privatisation, is based on the market, plus a very limited degree of information openness. It is a matter of open conjecture as to which of these two systems is closest to the free market utopia.

sumer representatives safeguard consumers' common interest, even though they are elected in a process where voting participation is only approximately 2-4%.

8.1.11 International price competitiveness

The Danish electricity system has the third lowest average electricity prices in EU. Only Sweden and Finland have slightly lower prices. The average Danish electricity prices for industry are around 50% of the German level. Small industrial consumers and farmers, who are typical Danish consumers, are paying three times as much in Germany as in Denmark. Furthermore, it should be mentioned, that Denmark has the lowest electricity prices in EU with regard to consumer groups with an annual consumption of less than 1 mill. KWh.

The price structure is characterised by the lowest price differentiation between large and small consumers in EU and probably in the whole world. Small industrial consumers and farmers even have lower prices than in Sweden.

Furthermore, the capacity payment is lower in Denmark than in any other EU country. This price structure is closely linked to the culture of co-operative ownership, where a precondition for fruitful organisational collaboration is that there is no large difference in prices paid by the different consumers.

Competitiveness at the home market

The new electricity reform has resulted in a very low production at the Danish power plants. This is mainly due to the establishment of excess capacity in Denmark, most of which was caused by the construction of three large power plants in Denmark in the late nineties. This has come at the same time as the opening at the market, and massive rain and snow in Scandinavia, making the power market extremely crowded in Northern Europe. The result has been electricity prices close to the short-term marginal costs of new large coal-fired power plants. But the Danish electricity system only has a very low debt, and therefore is relatively independent of the development at the capital market.

At present an adaptation to the changing regulation regime has been prepared in the new electricity law. The power distribution companies have got increased freedom to buy electricity from other power plants than their own.

At the foreign electricity markets

At present it is not possible for the Danish power companies to use the capital collected at the home market as base for electricity export and investments in other countries. In that sense the Danish power companies have a handicap in relation to PreussenElectra (Now E.O.N), and Electricity de

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France, Vattenfall etc. But no one hinders the Danish power companies in establishing independent limited companies for investment outside Denmark.

There is no real danger of losing the home market on a long-term basis.

So far it is **not** possible to use the money of the electricity consumers as base for electricity export, overseas investments or investment in new products.The "no debt" situation makes it very difficult for foreign companies to sell electricity based on long term contracts at lower rates than can be offered from the Danish power companies.

8.1.12 International market power competition

It should not be forgotten that a liberalized market (in economic theory) means, among others things, that there are (a) many independent buyers (b) many independent sellers and (c) a situation where the companies have no influence on the institutional setting on the marketplace.

At present there is a tendency to focus on the "independent buyer" dimension without any serious analysis of the process of developing market power and corporate political power.

Nevertheless, the real fight against the electricity markets is a fight against market power.

Although there is no free market at all in Germany, France or the United States, companies from these countries are presently buying parts of the electricity systems in the countries which have "liberalized" their markets. Currently, around 25% of the distribution companies in the United Kingdom are owned by North American companies. PreussenElectra has bought 35% of the former East German Company VEAG, and is now strengthening their monopoly power in the former East German area together with the other electricity companies from the former West Germany[35]. At the same time PreussenElectra buys more than 20% of the Swedish Company Sydkraft. The state owned monopoly company, Electricity de France, has bought 10% of Sydkraft, etc.

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[35] See"Verhandlungen zur "Energikonsensrunde Ost", which was agreed upon on January 31, 1996. In this agreement, the Minister of Industry, Günther Rexroth announces that the German power companies have agreed upon using "cross subsidization" to establish "barriers to entry" against electricity produced at independent cogeneration units and against electricity from other nations.

The real threat is not price competition, but that foreign power companies might be very interested in buying the Danish electricity system. That is why the ongoing discussion continues regarding the organisation of the electricity system. At the beginning of 1996 a consultancy firm, PA Consult, submitted a report for ELSAM, giving the advice that the power companies should be changed to joint stock companies. This proposal is currently under debate, meeting arguments regarding the threat of being bought by foreign companies, such as PreussenElectra. At present the Minister for Environment and Energy supports continued consumer ownership and does not seem to accept any foreign take over. In 1996 Parliament accepted a resolution supporting continued consumer ownership.

Conclusion regarding the market power question:
- Until the 1999 electricity reform, the Danish market was, to a relatively large extent, protected against foreign take-over because of the combination of consumer profit and the consumer ownership system.
- This protection from foreign take-over had been supported actively by the Danish Government until the 1999 power reform. (In this reform a majority in the parliament still supported the protection orally, but not in the legislation.)
- Specific interests at the director level could work for a "joint-stock company" model, paving the road for a later foreign take-over.

8.1.13 Democratic efficiency (The Danish direct electricity supply systems political dirigibility)

Strangely enough the political dirigibility, or the ability to be steered, of large companies generally is analysed when discussing the future organisation of the power system. We find it necessary not to analyse organisational suggestions, as if they all have the same features regarding their political dirigibility. Especially in situations where technological changes are needed, one should be aware of maintaining/developing organisations that can be regulated by the parliamentary process.

The above mentioned deficiencies in the technological innovation capability of the direct electricity system are not necessarily a catastrophe, inasmuch as this may be able to be compensated for by the parliamentary system taking over the direction. If the combination of public regulation and the direct electricity system have the technological innovative ability, then technologically conservative electricity system is not necessarily a problem. Therefore, it is interesting to see if the electricity supply system is politically dirigible. This question will be examined in the following way:

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The political dirigibility is determined in the boundary zone between the direct electricity supply system, the indirect electricity supply and the democratic process (the second order governance system, Figure 6.)

Conditions that facilitate the political dirigibility

When analysing the electricity system it is not sufficient to look at the direct electricity system. One must also look at the relations between the direct electricity system, the indirect electricity system, the consumers and the Government (the second order governance system in figure 6).

When analysing these questions, the following statements can be drawn:

a) There is no **vertical integration** within the fuel procurement. This differs very much from many other European electricity systems, such as in the German case, where the lignite mines are owned by the same organisation-that owns the power plants, as well as the transmission and distribution system.
   No coal miner will demonstrate if the use of coal decreases!
b) There is no great degree of **horizontal integration** in the subcontractors for power generation technology, e.g. the German electricity system, where the largest German Company, RWE Energie, is a part of a group which also includes building contractors that construct power and smoke purification plants.
c) There is no **horizontal integration** with other fuel companies. This is also in comparison with the German system, where the VEBA Group, which owns PreussenElektra, is also the owner of a company that sells fuel oil. In the VEBA case, the establishment of cogeneration units would decrease the turnover in the VEBA subsidiary "VEBA Oil Company".
   The interest against cogeneration, therefore, is much stronger in Germany than in Denmark.
d) There is no horizontal integration with other large industries. This is different from the VEBA Group, where PreussenElectra has sister companies dealing with the production of chemicals, transportation, oil, etc. Therefore no Danish industries are interested in high electricity prices, whereas in the VEBA Group, members of this group will sometimes gain more than they lose by high electricity prices.
   At the same time there will be no specifically low electricity prices for large consumers, like those that the large firms in Germany are getting.
e) It is consumer owned and the profit remains with the electricity consumers in the form of lower electricity prices, whereas, in the German electricity system, the profit goes to the shareholders. In the case of PreussenElektra,

these are private shareholders, and in the case of RWE, these are regional and district authorities.

In a Danish consumer-owned system, there are no strong interests working for higher electricity prices, whereas stockholders in a joint-stock company have a motivation for higher electricity prices.

f) There is no interweaving of specific electricity supply system revenue and the public sector taxation revenue. The public sector, with regard to its revenue, is independent of the electricity systems actual **structure**. This should be seen in relation to the Danish natural gas companies, where the local authorities are financial guarantors, and thus, economically dependent on the sale of natural gas. In Germany, local authorities are dependent on concession levies, which the electricity companies pay to them. Thus, the public sector with regard to their revenues is dependent on the share dividends of the electricity companies. A reduction in electricity consumption or the establishment of independent producers, in the German case, will result in reduced revenues for regional and district authorities.

   In the Danish system such a dependency does not exist.

g) **The Danish electricity system is a self-financing consumer profit system**

   The Danish electricity system has no debts.

   There are no capital owners whose share values drop when the electricity supply market becomes smaller. This means that the system has no real economic problems in connection with an actual fall in consumption. Therefore, the Danish electricity system, in comparison with the German system, **cannot** be threatened by a falling electricity production.

h) **The Danish electricity supply system is subject to demands on openness, with regard to prices and costs**

   This means that, to a relatively large extent, it is possible for participants in the democratic debate to examine the crooks and crannies of the electricity supply system.

Conditions which make the political dirigibility difficult

i) **Short-sighted advantages in the construction of a power plant, which binds district and regional politicians**

   The construction of a power plant, at a cost of 3 billion DKr, provides employment for the local labour force, during the period of construction and afterwards. ELSAM's payment regulations are so formed that it is the Power Company, which has the newest and most efficient power plant, that has the lowest electricity prices. Furthermore, electricity consumers, e.g. in Jutland-Funen, make a capital transference to finance the next power plant. This means that all consumers pay towards the new station, repre-

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senting 3 billion DKr regional investments, which no regional politician can refuse.

j) **The immediate effect on employment results in support** from the trade unions - especially the metal workers - when the power companies make application for permission to construct a new power plant. It appears to be of importance, in the political process, that employment in relation to the construction of a power plant is assigned to workplaces that identify themselves as energy related workplaces. The alternative to a new power plant is electricity saving, decentral cogeneration plants, etc. The workers in these alternatives are **dispersed**, employed in **multi-purpose organisations** (electrical, plumbing and heating services, etc.), generally **less aware** of their roles in the alternative energy game, and**weakly organised** in the trade unions.

k) **The electricity supply companies power position in the decision making process in the Central Administration**

The power companies have been and still are strongly represented in the decision-making processes in the Ministry of Energy and in the Energy Directorate. Thus, the interests of coal technology were taken care of in the seventies and the eighties. The new technologies did not and still do not have similar political and administrative opportunities and advantages.

The so-called "**Committee of Directors**" was a good example of this influence, in which the directors of ELSAM and ELKRAFT held regular meetings with senior staff from the Environmental Agency, the Energy Directorate and the Ministry of Energy. There are no recorded proceedings from these meetings.

The **Electricity Pricing Committee** is a second example, with 50% of the members from the electricity sector and no representation from environmental interests or energy saving technologies.

Electricity Prognosis Committee is a third example, where 7 out of 12 members are from the power companies[36].

The **Electricity Supply Statute** is a fourth example. The Energy Directorate is only an approving authority, with the competence to approve or reject. The power companies prepare the agendas, and decide what is to be applied for.

The **Electricity Strategy Committee** is a fifth example. It consists of members from the electricity sector and the central administration, and holds a number of meetings. The recorded proceedings are not publicly available.

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[36] The role of this Committee is described in "Offentlig regulering og teknologisk kursskift"; Henrik Lund & Frede Hvelplund; Aalborg Universitetsforlag, 1994.

8.1.14 Channels of consumer regulation in the Danish Electricity Supply System

A. "Liberalization", public regulation and ownership structure

In order to understand the Danish electricity supply system, and its second order governance system, we find it worthwhile to start with a short description of the present "liberalization" governance model, which has been implemented in many places throughout the world in the last decade. This "liberalization" paradigm, as discussed in Chapter 8, is limiting itself to a "three leg chair" strategy, dealing solely with a combination of market, parliament and public space (communication power), and excluding consumer ownership as an integrative part of an efficient regulation in the market.

Figure 30 illustrates the present "zeitgeist" liberalization paradigm.

Figure 30. Economical "Liberalization" or the "three-line" consumer power.

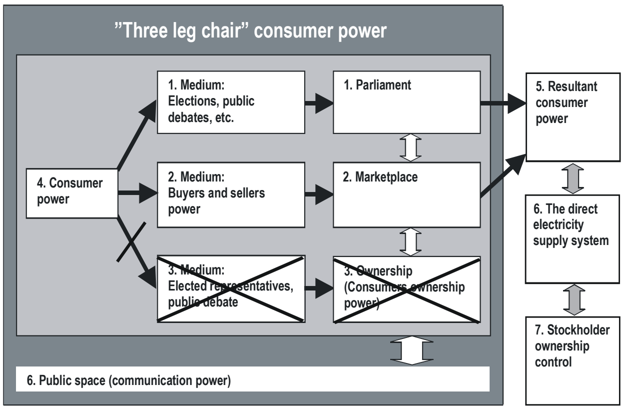

Figure explanation: *This system of regulation does not have the "consumer ownership" regulation possibility and depends solely on the function of the marketplace. The function of the marketplace also depends on public space (box 6) and the parliamentary political processes, which should control its institutions. However, the focus in the "liberalization" discourse has mostly been on "economic liberalization", empowering the consumers to buy where they want, and in that way control amount, price and quality of the "goods" (electricity) produced.*

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Instead of a consumer "first party"[37] *ownership, the ownership is removed from the consumer level to the "third party"*[38]*level in a stockholder ownership system, box 7. This ownership system has given the production technology*[39]*sector an interest in low production costs. On the other hand, it also has interest in the establishment of technical systems where the product is indispensable for the consumer, monopolies can be established, and which are generally expensive. Typical for the stockholder ownership model is furthermore, a motivation for high prices.*

We believe that there are very good reasons for extending the regulation paradigm to a "four line" governance model, including consumer ownership power as an important regulation method. This is especially true when dealing with techno-systems, like the ones linked to electricity production, which are very difficult to control by means of the the three line regulation system. The "four line" governance structure has , as shown in the former chapters, been used in the Danish energy systems with relative success, when compared with, for instance, the cost, price and innovation performance of electricity systems in other countries.

[37] By "first party" ownership it is meant that the owner is the same as the consumer.

[38] We define "second party" as the employees in the electricity companies, and "third party" as organisations or persons that are neither consumers or producers.

[39] The ownership system has also given an interest in techno-organisational systems that the consumers cannot establish themselves, such as energy conservation technologies, or systems which are very cheap on a long run basis. The ideal system is expensive (high turnover), necessary (no other opportunities for the consumer), and monopolistic.

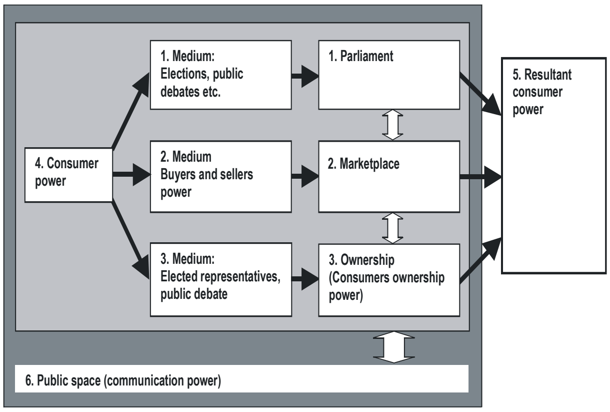

Figure 31. Economical and political liberalization, or the "four line" governance structure/consumer regulation.

Figure explanation: *It is labelled "economical and political" liberalization because it includes both consumer ownership control and parliamentary control. Both ways of control implicates political procedures in relation to election processes and bureaucratic procedures. Consequently, the figure also visualises the areas of political control mechanisms. These mechanisms should be examined with regard to democratic institutions such as openness[40] in the parliamentary system (box 1), and the performance of the democratic system linked to the consumer ownership of the electricity system (box 3). The economic institutions in which the economic "liberalization", box2, are embedded also have to be subdued to democratic control, which is why political liberalization is also important as a part of the "liberalization" at the marketplace.*
It is therefore important to note that the conditions of the public space (box 6) should also be under critical observation by the public. The "four leg chair" regulation model will degenerate if the information process is blurred and monolithically controlled by the large actors at the market in the parliament or in the administration.

[40] Increased openness with regard to information plus participation of economically independent members of public committees within the energy area. See chapter 11 in "Demokrati og forandring",Frede Hvelplund,Henrik Lund,Karl Emil Serup,Henning Mæng. Aalborg Universitetsforlag 1995.

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Looking at the consumer power in the Danish electricity supply system, as it was up until 1999, Figure 19 illustrates some of the important aspects of the "four leg chair" regulation process:

1. Whether a production system is efficient or not, seen in relation to short term as well as long term goals, depends on the balance between buyers' power, ownership power, the function of the Parliament, and the public space and communication process within which this power game is played.

2. Until the 1999 electricity reform, the Danish Electricity supply system was characterised as having no direct buyers' power at a market for electricity. In that way it was not possible for the consumers to buy kWh electricity from other suppliers than their own distribution companies and power plants. But no third party could establish a monopoly from this situation as the consumers themselves were, and still are, the owners. Therefore, it is not theoretically justified, as it is very often done, to talk about a monopoly situation in the neo-classical sense.

   Cooperative consumer ownership can be regarded as the **group version** of the core model of an individual consumer's private ownership of their cars, bicycles, houses, etc.

   The stock company model has a much weaker connection to the consumers, and could rather be called a sort of public ownership as it is seen from the consumer perspective is owned by a "third party". Seen from this perspective a stock company is much more a "relative" to state owned companies than democratic, well functioning consumer owned companies. So it is conceptually ironic that in the discourse regarding liberalization and privatisation, the consumers of electricity have managed to call "third party" ownership, as represented by the stockholder model, more "private" than "first party" consumer ownership, by the ones who use the good produced-in this case electricity.

3. It is often argued that in consumer owned co-operatives, the employees in the firms will capture the monopoly profit, which does not have to work efficiently, as they are safely employed within their monopoly area where there is no competition. As we have seen above, the cost and price development in the Danish system indicates that it has worked efficiently, both from a cost and price efficiency viewpoint. The reason for this seems to be a combination of openness with regard to costs and prices within the "Public space" (4) and through consumer elected boards of directors. In such a system, there is no direct price competition, but there is an indirect price

competition where the board of directors would put pressure on or even fire an administrative director, if his/her company did not perform efficiently in comparison with other companies. This is illustrated in Figure 32.

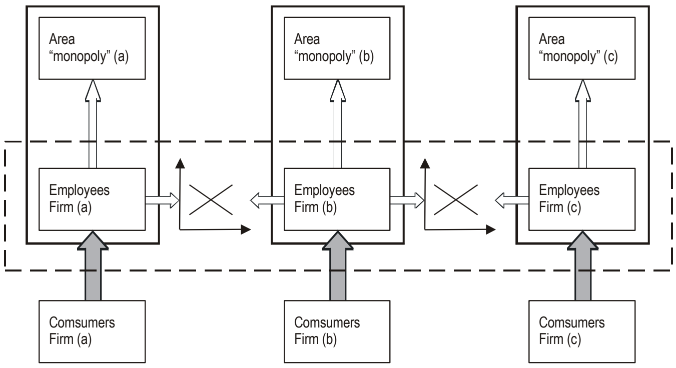

Figure 32. Factor price competition instead of kWh price competition.

Figure explanation: *We have three electricity supply firms linked to each of their consumer groups and "monopoly" areas (a), (b) and (c). We can see how there are three "monopoly areas, (a), (b) and (c) at the top of the figure, but there is no price market connection between these three markets. The consumers have to buy from each their suppliers, firm (a), firm (b) and firm (c). The firms are consumer owned and consumer controlled, which is indicated by the three vertical grey arrow at the bottom of the figure.*

The important observation from Figure 32 is that the consumer representatives can dismiss the director of the firms and that the director can fire the employees. It is important to note that ***there is a labour market with competition between directors and employees in this market.*** So if the consumer representatives in an electricity distribution company analyse the open price statistics for all other distribution companies and find the prices too high in their area, they can change the management of their firm.

When discussing liberalization, the tendency is often to talk about markets as one dimensional, only looking at the market for goods. But when we have a system where the consumers are owners of production facilities, the consumers can decide which production factors to employ. In this case the market for production factors, labour and capital is just as important as the market for goods.

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In Figure 32 the labour market is symbolised with the large "dotted" box. As a general principle it can be stated, that the market which is of interest, when evaluating, whether a system has competition or not, is the market which is within reach from a consumer action point of view. In the specific consumer ownership case, the democratic processes within the consumer owned companies should also be taken into a process of critical analysis. If there, as discussed in section 8.1.5. are serious shortcomings in the concrete democratic processes, such problems should be discussed and solved internal in the organisations. And if these organisations are not able to, by their own[41], to introduce democratisation reforms, the parliament should intervene.

B. Value added and regulation of etectricity supply systems

There is, as argued above, *a link between ownership structure, and adequate level of "liberalization"/competition.* In a consumer ownership structure it is the competition at the factor market, which is relevant, whereas, expressed in few words, in a stockholder ownership structure, the relevant "liberalization" level seen from the consumer viewpoint is at the electricity market. Consequently it is a logical mistake to call a consumer ownership system a monopoly system, if there is competition at the factor market, and if the democratic channels in the consumer democracy functions in a reasonable way.

There is also an interesting connection between regulation, ownership structure, and the value-added system of a specific techno-organisational electricity service supply system. Here we will shortly deal with this question.

When dealing with the public regulation discussions under this the "liberalization" discourse, the liberalization subject is this electricity supply system and its appurtenant value- added chain (the grey boxes in the value-added Figure 23).

In the two Tables 11 and 12 below, we will analyse the connections between both the three and the fourleg chair regulation model and these value-added levels.

[41] Often organisations do not have the ability to change their election rules, as the ones being elected so far are in power because of rules which should be changed. So why should they change the rules and in that way voluntary lose their power?

(1) Classical fossil fuel/coal based electricity system	(2) Value-added % of sale price	(3)Market liberalization	(4)Parliamentary/bureaucratic control	(5)Public space/communication control	(6)Resultant consumer power/"liberalization"
(a)Power production	9.3	+	+	Assumption is freedom of press politically and economically. Public openness policy.	(++) Difficult to maintain competition
(b) Transmission	3.4	Monopoly	+		-/+
(c) Distribution	14.6	Monopoly	+		-/+
(d) Total electricity supply value-added	27.3				Consumer control not establised. = <u>Inefficient "liberalization".</u>

Table 11. The "Three line" economic "liberalization" model, and the resultant degree of "liberalization".

Figure explanation: *+ means that there is an efficient increase in consumer control, or an efficient "liberalization" effect. (++) means that it is difficult to maintain a competitive situation. - Means that there is no efficient consumer control.*

Out of the 27.3% value-added, which is allocated to the electricity service supply sector out of the consumer level sales price, 9.3% is supposed to be regulated at a competitive market. The rest, 18%, will remain regulated by bureaucratic procedures, either via a publicly regulated private monopoly, or via publicly owned monopoly firms.

Table 12 shows the same situation for the "four line" economical and political "liberalization" model.

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(1) Classical fossil fuel/coal based electricity system	(2)Value-added % of sale price	(3)Market liberalization[42]	(4)Consumer ownership[43] control	(5)Parliamentary/bureaucratic control[44]	(6)Public space/communication control	(7)Resultant "liberalization"/consumer power
(a)Power production	9.3	+	+	+	Assumption is freedom of press politically and economically Public openness policy	+ +
(b)Transmission	3.4	monopoly	+	+		+ +
(c) Distribution	14.6	monopoly	+	+		+ +
(d)Total electricity supply value- added	27.3					++ Consumer control established= Efficient "liberalization".

Table 12: The "four line" economic- and political "liberalization" model, and the resultant degree of "liberalization".

Figure explanation*: + means, that there is an efficient increase in consumer control, or an efficient "liberalization" effect.*

What we are seeing in these two tables is a summary justification of the argument saying that the organisation of the Danish electricity service supply system, until 1999, was closer to an economical ***and political*** liberalization situation, than the present "zeitgeist" economic "liberalization". This conclusion is drawn under the assumption that the basic aim of liberalization is to increase

[42] We are saying here that the existing consumer ownership structure, with area "monopolies" for power plants, can be considered as a system with market competition at the "production factor" level. And as the consumers decide which production factors to employ in a consumer owned system, there is market competition at the relevant level, given,that the consumer organisations have a functioning democracy..
[43] The plusses are linked to the argument in foodnote 21.
[44] Here it is just an assumption.

consumer power in the production system in order to optimise the utility function of the consumers. Without any full scale experiments, as the ones going on now in New Zealand, California, the UK, etc., it is possible analyse the existing techno-organisational system, and to conclude beforehand, that the present "three-line" regulation model will continue to run into huge regulation problems.

C. Change of techno-organisation system and "liberalization" models

As we have argued in Chapter 5, a probable value-added structure for coming techno-organisatinal electricity systems might have a value-added change which looks like the one in the Figure 33 below.

From this figure we see that the value added in the electricity service supply system has decreased from 27.3% in the present classical coal-based system to 18% in present electricity conservation and renewable energy systems out of the total value added. This figure indicates that the important level of liberalization is not the markets where liberalization is implemented today, the grey areas, but the white areas in Boxes 3,4 and 5, which are growing in importance. So when making new regulation regimes it is important that there is secure competition between windmill-, solar cell-, biomass equipment, producers. That is the growing "liberalization" challenge.

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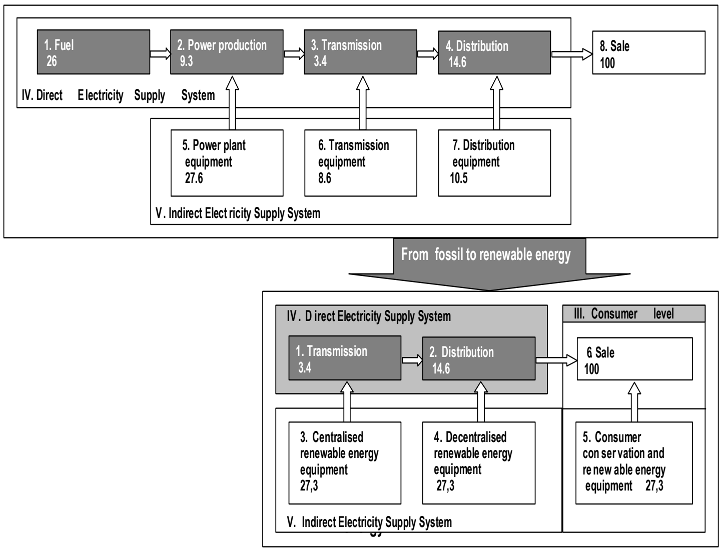

Figure 33. The increasing importance of the indirect electricity system.
Source: Same figure as 15.

8.1.15 Conclusion regarding the goal performance of the direct electricity service supply system as it was until 1999

This sub-conclusion deals with the characteristics regarding the sub-system, ***the electricity service supply system***, which is a part of box 2 in Figure 5, and box VII in Figure 6. The dynamics of this sub-system is interesting, as it influences how the larger system, ***the electricity supply system and its second order Governance system*** functions.

The system is relatively cost and price efficient on account of:

a) The consumer ownership organisation and returned profits
In a consumer ownership model, where the democracy has not degenerated[45], there is nor motivation for higher electricity prices whereas a share-

[45] In a consumer ownership system, where the election processes are undemocratic, and the level of information low, the system naturally can become ineffective, with too many employees and to high salaries and benefits for the managers at director level. It should however be mentioned, that this also might happen in a shareholder

holder owned electricity system has a motivation for increasing the electricity prices.

b) The relative openness on prices and costs in combination with elected consumer representatives, which can freely decide which directors to employ at the labour market, and which production machinery to buy at the market for capital equipment.
c) Prices are set in accordance with average production costs, and not as in a kWh price market system, according to the marginal costs of the production unit with the highest marginal costs.

Environmental efficiency: The system is conducive to increased consumption on account of:

a) The internal organisational dynamics causes a current motivation to construct new power stations. In ELSAMs area this is by means of competition between the 7 power companies and, in ELKRAFTs area, this is employment interest within the organisation.
b) The electricity distribution company which urge the consumers to economise on consumption, pays the same to new power stations per kWh as those who encourage increased consumption.
c) The electricity consumer, who economises on consumption, pays the same to new power stations per kWh as those who do not economise.
d) The democratic influence increases with increased consumption.

Regarding technological innovation, the system is technological conservative with regard to the introduction of radical technological changes.
This mainly has the following causes:

a) ELSAM and ELKRAFT are responsible for the long-sighted development plans.
   The chairmen and vice-chairmen of the large power companies sit on the boards of directors of ELSAM, and the managing directors of their power stations also have the right to participate in board meetings. Thus, ELSAM and ELKRAFT have a built-in interest and knowledge, which leads towards a systematic support for a centralised power plant development on the basis of fossil fuels.
b) The value-added profile of electricity conservation and renewable energy leads to lower turnover in the electricity service supply system .
c) The general historical situation of change indicates, that the old "fossil fuel sunset technologies" has organisational comparative advantages within the fossil fuel technologies, but rather comparative disadvantages in the re-

owned corporate system with oligopolies and monopolies.

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newable energy and electricity conservation “sunrise technologies”(See Table 1)

Regarding system efficiency

The coal based system has been able to organise cogeneration in the large cities, but has great difficulties when it comes to the organisation of the interplay between these large systems, decentralised cogeneration and windpower.

Democratic efficiency: The direct electricity service supply system is relatively[46] dirigible on account of:

a) independence of a horizontal and vertical ownership structure. The system is a small system from a value- added point of view. Not including fuel extraction like the German system, and having no ownership links to power equipment producers.

b) No direct economical links between a specific way of producing electricity, and the public finances, neither at the municipal nor at the state. In that way the public economy, and the public governance process is independent and not linked to the continued use of for instance coal for electricity production. More likely one could assume, that the links between the public finances and the use of natural gas might have influenced the support for the introduction of natural gas fired decentralised cogeneration.[47]

   In Table 13, the goal -performance of the ***sub-system***, the electricity service supply system is summarised.

[46] In relation to the power systems in for instance Germany.

[47] Although this is a valid hypotesis, the Governmental policy was a stand against decentralised cogeneration until 1989. In practice, the publically owned natural gas company preferred to sell gas to individual heat consumers, as the political fixed prices for this consumer group was the most advantageous for the natural gas companies.

Goals	Goal performance of ESSservice supply system	*Comments*	Need for public regulation
(1) Supply security	**+++**	No problems	None
(2) Price efficiency	**++-**	Almost no problems, due to consumer ownership, and a consumer profit system.	Necessary to secure openness with regard to costs and prices and a"non third part profit"regime. **+**
(3) Cost efficiency	**++ -**	Same as above, but some problems with a motivation for excess capacity.	Public regulation in order to avoid excess capacity +
(4)Conservation efficiency	**- - -**	No real motivation to decrease electricity consumption.	**+++**
(5)Innovation efficiency	**- - -**	No ability to radical technological innovation.	**+++**
(6)System efficiency	**- - -**	No ability to transcend to optimisation processes including actors outside the electricity sector.	**+++**
(7)Democratic efficiency	**+ - -**	Ability to endure public regulation, which decreases the market.	**++** Some needs for vitalising the internal democratic processes.
(8)Competitive efficiency	**+ - -**	Strong ability to compete on a long-term base. Low ability to compete due to no accumulated capital.	**++** When a market is introduced, as it is from 1999 an onwards, it is necessary to establish some capital protection.

Table 13. The "Goal efficiency" of the (sub-system), the 1999 Danish electricity service supply system.

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Table explanation: *Three crosses (+++) in the white areas indicates, that the goal performance is ok. Two crosses and a minus in the light grey areas (++-) indicates a general good goal performance, but with a need for some improvements. One cross and two minuses, the light grey areas, mean some goal achievements, but in general weak goal performance. In this case there is a clear need for improvements, which mainly can be introduced by public regulation measures. Three minuses, and dark grey areas, indicate very poor goal performance and a clear need for the introduction of public regulation measures.*

As we can see from the above table, there are two areas, where the Danish electricity service supply system has almost no problems, when seen in relation to the goals. The Danish electricity supply system has a very high degree of supply security, and is the most price efficient electricity supply system in EU Europe. Regarding price efficiency it should though be mentioned, that it has not been possible to introduce electricity tariffs, which establish a sufficient incitement for electricity conservation. Regarding Cost efficiency, the Danish system has a tendency to generate excess capacity. This tendency has never been so strong, that it has threatened the Danish position as the EU country with the lowest electricity prices.

The table also indicates where the weaknesses of the Danish electricity supply system are localised, when using the shown goals as measure. Weaknesses that might not be important when compared with other electricity supply systems in the world. These weaknesses are most obvious with regard to the inability of the Danish Electricity Supply System of developing and implementing radical technological changes with regard to environmental-, innovation and system efficiency. Furthermore the Danish electricity supply system also has, when comparing with the goals shown here, democratic weaknesses resulting in a relatively low participation rate in the elections for the representatives. But compared with other electricity supply systems in the world, the democratic performance, as consumer owned companies, is outstanding. As the Danish electricity companies have not accumulated free capital, their competitive efficiency is relatively weak in the short-run on a market, where there is excess capacity, and the price is determined by the short-term marginal costs of the systems. In this type of situation, accumulated capital is important in order to be able to pay the deficits evolving in such situations with excess capacity and prices based upon the short-run marginal costs.

9. The dynamics of the electricity supply system and its Second Order Governance system before the 1999[48] electricity reform

In the previous chapter we analysed the dynamics within the electricity supply system. Here we will combine this analysis with an analysis of the Public Regulation processes governing the electricity supply system.

Our point of departure is the conclusion regarding the internal efficiency in relation to the energy policy goals of the electricity service supply system, as it is shown in Table 13.

If we look at the electricity system as a natural part of a larger system, which includes the Parliament and the public regulation processes and measures, one cannot say just by looking at the electricity service supply system, whether its is functioning optimally, seen in relation to the goals or not. It is the results of this larger system seen in relation to the goals, which is of relevance when evaluating performance in practice. Therefore, in the following section we will analyse to what extent the public regulation-/second order governance system supplements the electricity supply system by repairing the "weaknesses"[49] of the internal dynamics of the electricity supply system. In the following we will deal with this question.

9.1 Public regulation processes and institutional reforms from 1975-1999

Lobbyists should, as underlined in the Figure 6 structure, be divided between the ones who are economically bound to the old fossil fuel and uranium solutions, and the ones, which are economically independent of these connections.

[48] We find it necessary to emphasise the development aspect of public regulation, in a situation, where radical technological changes are needed, implicating the development of new techniques and organizations.

[49] Quotation marks, as we cannot call it weakness, if we aknowledge it as a consequence of the division of labour between the electricity supply companies and the Parliamentary process.

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The Parliament should be regarded as an organisation that is able to establish a process of innovative democracy, making it possible for the "majority", which is economically independent of narrow economic interests on the energy scene, to design, choose and implement new technological solutions, if necessary, against the interest of the "minority", consisting of strong and concentrated economic interests in specific fossil fuel or uranium based technologies.

9.1.1 The interplay between the electricity system and the public regulation

We now will illustrate the economic motivation of the Danish electricity companies in three "situations", namely, a situation with excess capacity, a situation with no excess capacity, and a description of the fossil fuel system as a dynamic process which over time oscillates between the above two situations, and therefore should be understood as this type of "oscillation" process.

Situation a: Motivation for electricity conservation or renewable energy in a situation with excess capacity

The question here is, for which of the above three actors is continued use of coal the economically best solution, and for which actors is investment in renewable energy economically best?

Comparison of innovative motivation of the Danish coal based electricity service supply system with the motivation of an independent company.

Looking at the Danish coal based system in Figure 6 and 16, the direct electricity supply system consists of the value-added in the boxes 2,3,4, (13,7 øre/kWh), plus the capital costs from 5,6,7,8,9,10 (23,3 øre/kWh). If there is excess capacity in a period, the 23,3 øre/kWh will be fixed, and therefore independent of the level of power production. It is possible to fire some of the employees, but there will be though resistance within the organisations against this. In practice, the saved cost in the conservation case will be the fuel costs plus for instance 20% of the 2,3,4, salaries to the employees, or in this case around altogether 16 øre for 1 kWh, which is 32% of the sales price in a non-profit system as the one described in Figure 6 and 16.

We now assume, that it is possible to produce renewable energy based electricity and or electricity conservation for 30 øre/kWh.

As there is excess capacity, which is the case in Denmark and Northern Germany for the next 5-10 years, this company only saves around 16 øre, when 1 kWh of electricity is produced at the renewable energy plant for 30 øre/kWh. Therefore the companies will **lose money** if it introduces renewable energy, namely 30-16= 14 **Øre pr. kWh renewable energy produced by the company.**

In this situation, the electricity service supply systems will be strongly motivated against electricity conservation and renewable energy.

We now introduce a new company, which is totally economically *independent* of the fossil fuel company. We assume, that there is collaboration between the fossil fuel based power companies at the market, and that electricity consequently is sold for the full long term marginal cost plus profit for the coal-based electricity, or in this case 50 øre/kWh including transmission and distribution for electricity delivered at the consumer level.

For the sake of the argument, we are here looking at the specific case, where a renewable energy-/electricity conservation "plant" is producing for the consumer, without having to use the transmission and distribution grid. It is the worst case situation seen from the viewpoint of the fossil fuel based system.

As the cost of electricity conservation and/or renewable energy production is 30 øre/kWh, the *independent firm* achieves a **yearly gain of 20 øre/kWh** when producing renewable energy or electricity conservation instead of buying coal-based electricity. So this *independent* company is motivated for establishing a renewable energy or electricity conservation "plant".

Meanwhile, in the real world, the coal-based company will, in this situation try to lower the sales price, where there are newcomer competitors, and/or establish a situation or governance system[50] with oscillating prices, and in these ways establish a “barrier to entry” against renewable energy technologies. This will be done by in periods to sell electricity at prices far below the long term marginal costs of coal based electricity production. So even in this situation, reality might prove investing in renewable energy uneconomical for the independent company, if there is no public regulatory interference.

The motivation of society in a situation with excess capacity
On a short-term basis, the society will gain money by utilising the short-term excess capacity at the coal-fired plant by and abstain from building renewable energy systems. In a long-term perspective, such a policy will hinder the

[50] Could be a system with “Green Certificates” for renewable energy, which changes the regulation system from fixed prices and variable amounts to a system with fixed amounts and variable prices. (See chapter 10.3)

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technological development of renewable energy technologies, which, in this example, could produce electricity at lower long-term social costs.

The above simple example illustrates that it is worthwhile not only to look at the long-run marginal costs when discussing technological innovation processes, but also to look at the dynamics of the interplay between political processes, and the short-term marginal costs of established old technological systems. There will be a motivation for creating alliances between the coal-based organisations, and economist, which analyse the world by means of neo-classical economy, dealing with technology within a static worldview, and regarding businesses as being undifferentiated with regard to economic-, organisational and cultural motivation.

Situation b: Motivation, when there is no excess capacity
In a situation with no excess capacity, as in California today, or what might evolve in Northern Europe within five to ten years, one could imagine that electricity service supply companies would have a higher interest in electricity conservation and renewable energy technologies, when established within their own organisations. It is the result of the analysis here that we will conclude that even in this situation there will still be the resistance against these new technologies. This is because renewable energy technologies requires organisation cultures, which are very different from the organisation cultures linked to the use of fossil fuels (See Table 1 and section 5.4.) The established direct Electricity Service Supply Companies have a strong comparative advantage within knowledge regarding producing electricity services by means of large fossil fuel plants in combination with high tension transmission systems and low voltage electricity distribution systems. They do not have a corresponding comparative advantage in the production of electricity conservation and renewable energy based services.

Furthermore, the strategic change from fossil fuel technologies to renewable energy and conservation (REC) technologies means a considerable decrease in value added within the existing fossil fuel companies. So, strategically, it is also in a situation with no excess capacity and very cost-efficient REC technologies, against the interest of the present fossil fuel companies to further investments in renewable energy and energy conservation technologies.

Consequently, one cannot expect fossil fuel companies to further and deliberately implement electricity conservation and renewable energy technologies, even in periods of no excess power plant capacity.

Situation c: Barriers to entry and oscillation between excess- and undercapacity.

In addition to the above arguments, it is probable, that fossil fuel based systems should be regarded as "by nature" and by "intention[51]" oscillating between a situation with excess capacity and low prices and a situation with not sufficient capacity and high prices. This "by nature" oscillation concept could be described as a behaviour, which in its effects strengthens the competitiveness of the "techno-/organisation" of uranium and fossil fuel technologies against potential newcomer technologies. If the long term marginal cost including profit ***at the power plant*** level is 25 øre/kWh there are two strategies, which can assure coverage of production costs plus profit:

One "strategy"[52] is to establish a situation, approaching a constant price of 25 øre/kWh.

A second strategy would be to establish an oscillating price situation, where the average paid price is still 25 øre/kWh, but distributed with 12 øre/kWh in year, 2,3,4,5, 60 øre/kWh, in year 6,7, 10 øre/kWh in year, 8 and 9, and 50 øre/kWh and year 10 at the power plant level. This second strategy gives- as mentioned- the same average price, but has one additional advantage seen from the point of view of the uranium and fossil fuel "techno- organisations", namely, that it constitutes a rather efficient "barrier to entry" against newcomer technological paradigms such as electricity conservation- and renewable energy systems.

One of the basic preconditions for the successful Danish, German and Spanish introduction of wind power was the public regulation linking the payment for wind power to the consumer price plus a public service payment from the state for the supply of CO2 free electricity. This gave a stable price making it possible for new organisations, in the specific case, wind power cooperatives, to borrow money in the banks for the windmill investment. This possibility would not have existed on a market with the same average but oscillating prices. Consequently, the second strategy would have protected the fossil fuel and uranium based "first comer" techno–organisations against the newcomer technology, in this case windpower.

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[51] As there are strong "barrier to entry" qualities linked to a strategy based upon oscillating prices, it would be improbable, that nobody in the fossil fuel companies knew about this. And if they knew about it, it would be improbable that they would not try to use it consciously.

[52] A "strategy" here does not necessarily include a subject organisation that elaborates the strategy.

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At present, January 2001, the California electricity system has insufficient capacity, resulting in power prices, which on average are far above the long term marginal costs of power productions[53].

In Northern Europe there is at present excess capacity which is supposed to last until 2005/2008. This has resulted in electricity prices at the Nordpool market, which, due to the large proportion of hydropower at the Scandinavian market are often below the short term marginal costs of modern coal fired power plants.

A capacity and price oscillation process is very difficult to withstand for newcomer electricity conservation- and renewable energy technologies.

Concluding it can be stated, that the motivation for electricity conservation will, in the case of excess capacity, insufficient capacity and with regard to the capacity and price oscillating strategy, be, that the fossil fuel based organisations will not have the economic motivation to invest whole-hearted in electricity conservation and renewable energy technologies. Their economical and organisational motivation structure is not geared to engage in this type of radical technological change. Fossil fuel based energy companies have an organisational and economical motivation structure, which, with regard to the introduction of energy conservation and renewable energy technologies, is very different from the motivation structure in firms, which are independent of fossil fuel interests. The banal truth thus is that fossil fuel based energy companies strongly tend to want to continue using fossil fuel based technologies, as that's where they have their organisational comparative advantages and their "hardware" investments. Consequently these firms tend to go for "end of pipe" technological improvements, such as smoke abatement measures or a change from coal to nuclear technologies, which fits easily into the fossil fuel organisational structure.

This conclusion has consequences, when dealing with public regulation measures within the following areas:

- To what extent public regulation should rely on corporate collaboration with existing fossil fuel and uranium companies, or rather develop models of collaboration with groups and companies, that are independent of fossil fuel interests.
- To what extent the situation can be regarded as a win/win situation, or

[53] On December 14th, the price of electricity on the California Power Exchange reached 1,4 US$/kWh. (The Economist, December 23,2000,pp.72-73), with 0.015 US$/kWh being a typical short-term marginal cost at a coal fired power plant.

should be regarded as a situation, where there are losers and winners.

- To what extent regulation tools like "Green Certificate Markets", and a system with "tradable CO2 permits" should be introduced.

One of the main public regulation and innovation problems at the energy scene is that the technological solutions needed in meet to-days energy policy goals require radical technical and institutional changes. By radical technological changes is meant that changes are needed not only at the technical level, but also at the level of knowledge, organisation and product. In a situation of change with these characteristics a regulation model along the lines of negotiated regulation between the central administration and the large energy companies represents the fundamental problem, that the new technologies, are not present at the negotiation table. The owners and top managers of established fossil fuel companies naturally will argue, that they are more than willing to implement the new renewable technologies as soon as these technologies are economically feasible. But due to the fact, that the fossil fuel companies would lose, if the renewable energy and conservation technologies are getting success, the fossil fuel companies represent the economic setting/organisation in society in such a waythat the renewable energy technology , as illustrated in Table 10, will come up with the worst result in any economic feasibility study.

9.1.2 The need for a non-corporate public regulation process

As a consequence of the above arguments, the renewable energy and conservation technologies will not get acceptable conditions under a regulation model, which is characterised by negotiations between the fossil fuel energy companies and the central administration. Therefore, the parliament should establish regulation procedures, where groups independent of the fossil fuel interests are representing the new renewable energy and energy conservation technologies at the "negotiation table".

Naturally, we know that it is not easy for politicians wanting to be elected for the next term to govern against existing wealthy and focused[54] minority interests, such as power companies and natural gas and oil companies, which have the economic motivation and resources to lobby heavily for their own interests. On the other hand, it is also important to emphasise what is often forgotten, that a functioning democratic process is the only place where there is **always** a potential majority against any short-term and narrow economical interest group. The parliamentary democratic process, with its innovation gains for society, is a

[54] By focused we mean that power companies are producing mainly power. The alternatives to power companies are often electricity conservation measures, which have to be taken in companies having totally different main purposes.

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potential forum for radical technological innovations. However, from the perspective of dominant firms in the market, the democratic process poses regrettable innovation risks that could threaten their standing in the market.

Until the mid-70s, there was very little **public regulation** of the electricity system. Since then there has been a growing public attention and intervention in the affairs of the electricity system.

The main questions at the end of the 1970s and in the early 1980s were nuclear power and the introduction of natural gas. Nuclear power was removed from the political agenda in 1984, while natural gas represented a new fuel distribution infrastructure that formed the base for a new competitive situation for the Danish electricity system.

From 1975 until 1983, when the Parliament removed nuclear energy from the Danish Energy plans, the anti-nuclear power movement, OOA and the pro renewable energy movement OVE were very strong. A generation of motivated people became educated in the area of energy issues following these events. This generation is now working at universities, in the school system, in consultancy firms, in the Ministry of Environment and Energy, and in the press. This movement continued as a sociological and psychological environment behind the energy planning discussion throughout the eighties and nineties. During this time, the Parliament allocated research funds for the development of renewable energy prototypes in biomass, solar and wind energy from an institution totally independent of the old energy companies[55].

The end of the 1980s witnessed the completion of the natural gas network. This network represents a physical infrastructure, **which has made the extensive development of decentralised cogeneration of power and heat on the basis of natural gas possible everywhere in Denmark**.

The 1990s was a period during which the Danish electricity system encountered problems of hitherto unseen dimensions. At the same time they were of a character which the electricity system was not accustomed to deal with, and could not solve within its organisation.

The most important **external causes** of these problems were the **environmental problems** and increased international competition for electricity consumers, in connection with the beginning implementation of market regimes and within the energy sector.

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[55] Styregruppen for vedvarende energi.

The public regulation process was (and still is) a dialectic process between "negotiated regulation" between the central administration and the traditional power companies, on one hand, and **active and open public debate** (with participation from grass-roots movements, proponents for the new technologies, the general public, and Members of Parliament) on the other hand.
One way of describing the main components of this process is described in Figure 34.

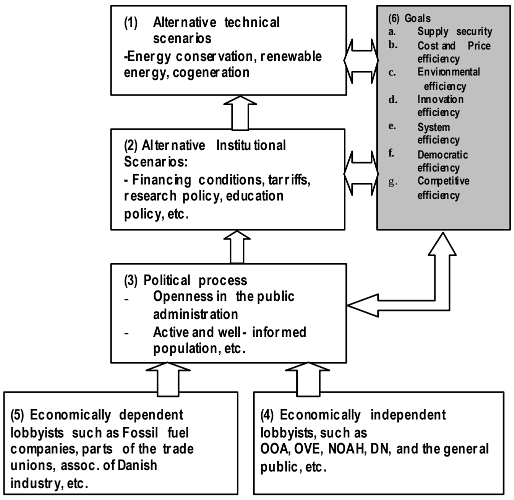

Figure 34. Main components of the energy policy discourse, 1975-1999

Figure explanation: *The figure illustrates the Danish energy planning discourse with its combination of:* ***Goals,*** *Box 6, description of* ***alternative technical scenarios****, Box 1, description* ***of alternative institutional scenarios****, Box 2,* ***the political process****, Box 3, with the* ***economically dependent[56] lobbyists****, Box 5, and* ***the economically independent lobbyists****, Box 4.*

The energy planning discourse typically has developed within a process between the components of Figure 34, resulting in a dialectic process that some-

56 An economically dependent lobbyist, is a lobbyist who is privately and economically influenced by the decision being discussed. It can be someone employed within a fossil fuel company or selling equipment or getting economic support from such companies (political parties, pressure groups, or researchers). An independent lobbyist is not subject to such influence upon her/his private economy.

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times resulted in victories for the economically dependent lobbyists, the power companies, the association of large industries, and the metal trade union (which organises the workers at the large power plants). In other situations, the economically independent grass-roots movements won victories, for instance, with regard to the large reforms resulting in an extensive introduction of wind power and decentralised cogeneration plants. In the nineties one could say that both the proponents for large coal-fired power plants and the supporters of decentralised cogeneration plants won, which resulted in the establishment of a huge excess capacity at around the year 2000.

If we start by examining the **environmental problems,** a massive parliamentary majority supported the goal that Denmark, in the period from 1988-2005, should reduce the CO_2 emission by at least 20%. When this type of legislation was possible in the late eighties, it was linked to the fact that there are many parties in the Danish Parliament. The old large parties, the Social Democrats, the Conservatives, and the Liberals are all linked to interests connected to the fossil fuel companies. But some of the smaller parties are independent of these links, and at the same time they sometimes have concrete political influence. For instance, in 1989, the Minister of Energy came from the small Liberal Radical party. He changed the energy policy and was responsible for the new "Energy 2000" plan from 1990.

The goals of the new energy policy started with “Energy 2000” and are now being sought for implementation by means of the Ministry of Energy's energy plan "Energy 21”.

With regard to the **supply of electricity**, this plan calculated that:
- The installed capacity of decentralised cogeneration of power and heat must be increased from the present 1700 MW to 2000 MW in the year 2015. This should be seen in relation to a total installed non-wind capacity of 10500 MW.
- The effect from wind generators should be increased from 1200 MW[57] in 2000 to 1800 MW by the year 2005, and 4000 by 2030.

Recently, Parliament demands to the electricity system have been specified so that the electricity system has been charged with a specific obligation of reducing its CO_2 emission by at least 20% of the 1988 level before the end of the year 2005.

[57] The installed wind power capacity at the end of the year 2000 has reached 1500 MW.

The politicians did not only give “lip service” to green plans. They also backed these plans in the nineties by actual measures for their energy policies. Amongst these measures may be mentioned the following institutional changes:

a) Introduction of a system of energy levies, including a CO_2 levy. This levy is 0.65 DKr per kWh for households and a number of service enterprises, amounting to about 60% of the kWh price. The levy for industry, agriculture, and market gardens, is only 0.10 DKr per kWh, amounting to 15% of the kWh price.
b) CO_2 subsidy of between 0.07 and 0.10 DKr per kWh for electricity produced by cogeneration plants powered by natural gas.
c) In 1994, the Integrated Resource Planning Statute was brought into operation. This Statute requires the electricity system to prepare 20 year energy plans every second year. On this basis, the citizens will be kept aware of whether investments are to be made in plants, or consumers are to be affected by investment in energy effectiveness.
d) In December of 1995, a law was passed by Parliament establishing a set of regulations regarding the sale of electricity from decentralised cogeneration plants. The law states the right to sell electricity from decentralised cogeneration plants to the public net, at a price equivalent to **the long-term avoided costs** in the electricity system. This means a payment including capital costs pr. kWh of large coal power plants and transmission network.
e) On April 16, 1996, a law proposal regarding a certain "liberalization" of the Danish electricity market was proposed by the Ministry of Environment and Energy (Ministry of Environment and Energy, 1996). The main content of this law was that:

   - Electricity distribution companies and companies with a consumption above 100GWh/year are allowed to buy electricity at the market, for instance, from Norwegian or Swedish power companies.

   - Electricity from cogeneration plants and renewable energy plants have a priority in the market, meaning that any distribution company is obliged to buy their portion of the total electricity production from these plants. During the winter months, the production from these plants will often be 80-90% of the whole electricity market in Denmark. This market share is increasing. During the summer months this proportion is naturally much lower.

   - If any costs are connected to the above-mentioned obligation, these costs are equally distributed among the consumers of electricity.

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This law is introduced in order to protect the Danish environmental "public service policy" as the market is partly opened for the new market regime.

On the public regulation process in Denmark **in the nineties**, the following can be concluded:

- It has, in several cases, been possible to mobilise the democratic process in such a way that radical technological changes have been introduced and implemented.

This is, among other things, due to a combination of:

- A specific balance in the parliament resulting in a period with a "green majority" combined with a system with many parties in the Parliament, some of which have no interests directly linked to the power companies. These parties could then, in specific situations, become the deciding factor in the Parliament[58].
- Easy public access to communication with members of Parliament.
- Grass-roots movements working during the seventies and eighties, educating many people within the energy area, and in that way, spreading this knowledge to almost any level in society.
- The financial possibility of independent research at universities and new centres for renewable energy[59].

The latest legislative move regarding market access, and a continuation of the energy policy from "Energy 2000", shows the beginning of a change from "challenged and negotiated regulation" to "challenged legislative regulation". This has been made necessary partly because of the pressure for the changing market regimes around Denmark.

9.1.3 To what extent does the Danish Public regulation compensate for the "shortcomings" of the goal efficiency of the direct energy supply companies?

At the end of the previous Chapter 8, in Table 12, we localised the areas where the Direct Electricity Supply system could not, on its own, fulfil the described energy policy goals as described in Box. X in Figure. 6. The fulfilment of these goals should be achieved within the larger system described in Figure 6 as the electricity supply service system plus its second order Governance systems. In plain words, the electricity service supply system could only function in ac-

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[58] . This situation seems to deteriorate in these years where the green majority is disappearing according to current opinion pools.

[59] For instance the "people's Center for Renewable Energy" in Ydby, Thy.

cordance with the goals if supplemented with a public regulation. The question now is whether or not and to what extent the Danish public regulation measures have improved the larger system in line with the described goals.

Goal B: Price efficiency

In a consumer owned system, price efficiency is, with regard to the average price, equal to cost efficiency. There is no ”third party” capital owner that could accumulate excessive profit, as the consumers themselves are the owners. The Danish Electricity supply service system is, as shown in Section 8.1.7. very price efficient when looking at the development of the average electricity prices in Denmark compared with the electricity prices in the EU.

Furthermore, it is important to emphasise two other main characteristics with regard to price structure in the Danish system:

- Firstly, the Danish electricity system has the ”flattest” price structure in the EU, meaning that the Danish price structure has the smallest difference between large and small electricity consumers.
- Secondly, the Danish price structure has the lowest capacity payment, when compared with other electricity systems in the EU.

This characteristic of the price structure is not surprising, as the prices in the Danish system are determined by political power heads in the consumer ownership organisations, and not by buying power (money) at the market, or negotiation power of a strong heavy industry lobby in a state owned system. The lobby power of the heavy industries in Norway, Sweden, Finland, Germany and UK is comparatively much higher than in Denmark, which has a business structure with relatively many farms, small firms and industries. The large energy consumers linked to the heavy industry can be counted on one hand, and therefore, have a relatively limited lobby power, in relation to the conditions in our neighbour countries.

Public regulation has assured two main features, namely, openness with regard to prices and costs, and a ”non third party” profit system, where it is not allowed to establish any profit to be used for other purposes than electricity supply services. So no third party, such as a shareholder or a municipality, has been allowed to take a profit from the electricity supply sector.

This public regulation has managed to establish a situation, in combination with the internal dynamics of a consumer owned electricity supply system, that has secured the lowest electricity prices in the EU.

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Goal C: Cost efficiency

As discussed in Section 8.1.7, the Danish electricity supply system seems to be rather cost effective, with regard to its centralised power generation, transmission, and distribution on the basis of fossil fuels (coal). However, the Danish system does have a cost problem, when looking at its tendency to establish excess power plant capacity. This tendency can be ascribed to:

a. Almost no interest paid on new investments. An electricity law allowing the power companies to pay 75% of the power plant in advance via the electricity prices.
b. An internal democratic structure, which, in the ELSAM area, establishes a competition for new power plants. See Section 8.1.5.
c. No tax on capital, which means that capital is very cheap for the power companies.

The power companies cannot build a new plant without the acceptance of the Ministry of Environment and Energy. So, in principle, it should be possible to hinder excess capacity by means of the public regulation process.

In practice, the public regulation process has not been able to perform this "brake" function[60]. Consequently, the electricity supply system has established excess capacity, especially in the nineties, just before the 1999 liberalization bill was passed. Nothing indicates, though, that the Danish organisational "construction" has developed more excess capacity than the state owned and monopoly governed systems around Denmark.

Looking at the larger system, the electricity supply service system and its second order governance system, one might conclude that there are difficulties in avoiding the establishment of excess capacity.

1999 remaining problem 1: Regarding cost efficiency there was still a tendency to establish excess capacity.

[60] This problem has been analysed in "Offentlig Regularing og Teknologisk Kursændring", Henrik Lund og Frede Hvelplund, Aalborg Universitetsforlag 1994.

Goal D: Conservation efficiency

Is the Danish electricity system conducive to increased consumption?

The Danish electricity system is conducive to increased consumption, on the following grounds:

- A capital transference system where the electricity distribution company (and the consumer) initiate reduced consumption and pay the same per kW of new capacity as the electricity distribution company (and the consumer) which further increased consumption.
- A tariff system where the average price per consumed kWh falls according to the size of the increased consumption. This is caused by a system of consumption-related levies, which, in a number of areas, are as high as 600 to 800 DKr. per consumer household.

The electricity supply system has no internal motivation for decreasing electricity consumption by introducing a price system where there is no fixed price and where there might be no capital subsidy to the ones increasing their electricity consumption.

Strangely enough, the public regulation process never has been able to change the tariff structure towards a system that motivates electricity conservation[61].

***Remaining problem 2,* regarding conservation efficiency:**
The large system (the electricity supply system plus the second order governance system) has not been able to introduce electricity tariffs which further electricity conservation, although this theme has been on the agenda several times during the last 20 years.

As shown in Chapter 8, the Danish electricity service supply system, on its own volition, is not able to implement the necessary radical technological changes without parliamentary intervention.

It does not take the **initiative** to introduce radical technological change, and it **systematically opposes** the implementation of such changes.

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[61] This is interesting, as there have been proposals to change the tariff structure several times within the last 20 years. This “minor” reform proposal seems to have met so much resistance between the administration of the fossil fuel companies that it was never implemented, nor seriously placed on the political agenda.

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Since the beginning of the study period (1972), the electricity supply system has not taken any initiative for a general introduction of electricity saving, decentral cogeneration plants or utilisation of renewable energy resources.

The demand for the introduction of these technologies in energy policies has come, and still comes, from grass-roots movements, in combination with the parliamentary process. Reforms, which make it possible for these technologies to enter the market, have also come from the popular movements and Parliament.

During the course of the whole period, the electricity supply system has systematically opposed the introduction of these new technologies.
The systems strategy has:

a) Made it difficult for a competitive technology to enter the political agenda.
b) Opposed the practical implementation, if the new technology has been put on the political agenda.
c) Attempted to take possession of the new technology, if this opposition has not been successful.

Technological conservatism appears to be caused by:

a. An election system with a series of indirect elections, which are directed towards strategically designed organisations. Representatives from the centralised power technologies dominate ELSAM and ELKRAFT.
b. The general characteristics of an electricity system with a value-added chain as shown in Figure 8, combined with the above mentioned tendency to generate surplus capacity of the old coal-based technology. In such a situation and organisation, the new technologies have to compete with the short term marginal costs of the coal technology. This makes the existing power companies the least prone to adapt any new technology, which might result in decreased production of the centralised fossil fuel-based electricity supply service system.

***Remaining problem 3,* regarding innovation efficiency:**
- Insufficient inclusion of economically independent groups at early stages of the planning process (too indecisive electricity conservation measures).

The Danish Parliament, so far, has shown some ability regarding the introduction of radical technological changes at the energy scene. This ability has to do with a combination of the development of a strong public debate on energy questions in the 1970s regarding nuclear energy and a Parliament with some small political parties, which are independent of the lobbyists of the power companies. The public debate was developed by grass-roots movements, which, again, educated many people on energy questions.

The Danish political system has been able to introduce a set of regulation measures establishing radical technological changes, which have often been against the will of the power companies. The process has been a dialectical process between a tradition of negotiated regulation and another tradition of public interest and interference. Here we call this regulation a praxis for "challenged negotiated regulation".

Compared to the regulation performance with regard to technological innovation in other countries, the Danish Public regulation can be characterised as relatively outstanding. But seen from within, an array of shortcomings come to light, such as:

a. A very slow innovation process producing economic losses. For instance, the development of cogeneration went on from 1976 to 1990 before a breakthrough was established. In the meantime, a lot of time was wasted, and the established power companies had built new coal-fired power plants representing an expensive excess capacity, when added to the decentralised cogeneration plants being built in the nineties. This expensive and slow innovation process might be caused by a public regulation procedure that does not include economically independent groups early enough in the planning procedures.
b. An inability to introduce massive innovation procedures at the area of electricity conservation.

Here we are dealing with the ability of the electricity system to cooperate with technological systems outside the electricity sector. Cogeneration is the clearest example related to this dimension of efficiency, where the Danish electricity system has been able to collaborate with the heat markets in the larger cities since the fifties. This collaboration has developed without massive interference from the state level.

The collaboration with the decentralised cogeneration technology has been much more difficult, and the electricity supply service system resisted this technology in a very long process of resistance, lasting from 1976-1990. Around 1990, the established electricity system lost the battle against decentralised cogeneration in Denmark. Public regulation rules supporting decentralised cogeneration were forced upon the electricity sector during the late eighties and nineties by the Parliament.

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The latest technological ”problem” requiring system efficiency is the steering problem linked to the large proportion of wind power and cogeneration at the electricity market. Here, the established electricity system does not seem able to establish the necessary decentralised ways of regulation. Instead, it adheres to the way of regulation linked to high voltage grids combined with large coal- fired plants as regulation units.

The public regulation did not establish institutions making it attractive to coordinate the increasing wind- and heat-steered electricity production locally, in order to avoid being forced to export the electricity at very low prices at the Nordpool market.

***Remaining problem 4,* regarding system efficiency:**
No public regulation measures are introduced in order to facilitate regional coordination of fluctuating windpower, cogeneration and consumption.

Goal G: Democratic efficiency
One way of looking at the levels where the consumer can influence their electricity supply service system is shown in Figure 31.

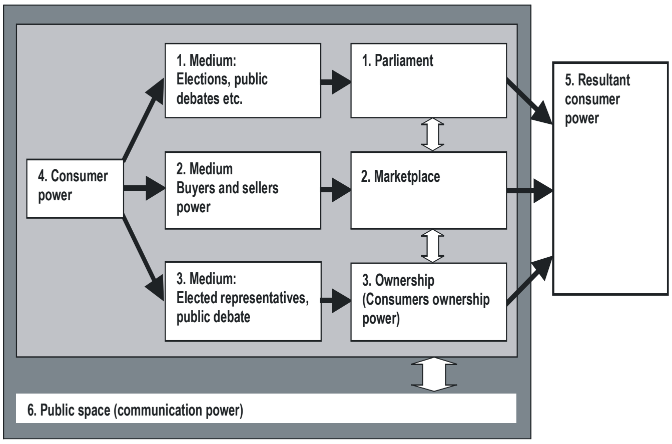

Figure 35. Levels of consumer regulation

Up until the electricity reform of 1999, the Danish system was characterised by a consumer owned system (Box 3), where the consumers could chose between different suppliers of electricity at the market, but they could choose between different directors, employees at the marketplace (Box 2). In that sense, there was market competition in the Danish electricity supply system. Whether this system functions or not, seen in relation to establishment of efficient consumer influence, depends on the way the democracy functions within the electricity service supply system and within the Parliament (the second order Governance system). These processes are then dependent upon the function of the communication sphere (Box 4).

First, we will look at the function of the democratic processes within the electricity service supply system (Box 3). It has many weaknesses, when evaluated against the goals of the electricity system as shown in Figure 31. These are (among others):

- The articles of association mostly allow a small majority of the elected representative to elect all the members of the board of directors. In that way, fundamental innovations are hindered, as they are almost always coming from minorities.
- With conditions as the above mentioned, it is very difficult for people with new ideas to get influence. This reduces the interest in participating in the election processes. The number of people participating consequently oscillates between 2 and 10%.

Regarding the democracy in the consumer owned electricity system, one can conclude that it works with regard to the three goals, **a. Supply security, b. Price efficiency** and **c. cost efficiency**. With regard to the fulfilment of these goals, it does not really matter that only a small minority is voting, as this small minority has the same interest as the non-voting groups with regard to the fulfilment of these three goals.

When looking for the innovation ability of the organisation, it can be concluded that it does not exist when talking about radical technological innovations.

The next question is whether the Danish electricity system is (being) organised in such a way that it can be directed by the parliamentary system?

Our conclusion is that the Danish electricity supply system has features meaning that the causes of relative political dirigibility are:

- It is a self-financing non-profit system which, financially, can survive in a decreasing market. From 1990 to 1999, ELSAM, the electricity supply sys-

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tem in Jutland-Funen, lost 30% of its market without getting economic problems. In the case of a joint stock company, like the German Preussen Electra, the result of such a decrease in market share could easily have resulted in heavy drops in the value of the shares.
- As there is no commercial competition, there is openness on prices, costs and development plans.
- The Danish direct electricity supply system only counts for 27% of the value added in the whole electricity supply system, as it owns no coal mines, and produces no capital equipment.
- The public accounts are not dependent on income or expenditure related to any specific electricity supply structure.

***Remaining problem 5*, regarding democratic efficiency:**
The Parliament and the public administration have not, so far, introduced systematic methods which secure the influence of economically independent lobby groups.
The election procedures of the electricity service supply system have not yet been improved sufficiently.

However, this dirigibility is not worth very much if the electricity system captures the central administration, and thus decides the type of public regulation to be implemented. There has been a strong tendency in that direction by the establishment of a number of closed committees, consisting of members from the electricity sector and the central administration. One of these committees, the Electricity Strategy Committee has been directly involved in the preparation of the new Electricity Supply Statute.

Goal H: Competitive efficiency

Can the Danish electricity system compete under the new international regulation regime?

Yes, due to cost efficiency and a high level of consolidation, the danger of price competition at the Danish home market is very low, seen on a long-term basis.

On a short-term basis, there is a danger that the Danish power plants cannot survive a period of excess capacity in the German and Scandinavian electricity system. This is due to the fact that the Danish power companies have no free capital and will have difficulties in surviving a period with prices determined by the short term marginal costs, which are as low as 10 øre/kWh.

Nevertheless, the real danger is linked to a potential sale of parts of the system to foreign power companies, for instance, PreussenElectra, Vattenfall, etc. But this is, due to the Danish consumer ownership structure, not a very easy process, as it has to be approved by the many elected representatives in the electricity system.

The "take over danger" could be a reality in a scenario where the power companies run into difficulties due to a period of very low electricity prices at the spot market, forcing them to seek capital by selling out shares to energy holding companies and/or their Scandinavian and German competitors.

***Remaining problem 6*, regarding competition efficiency:**
Due to a combination of consolidation and no free capital, the Danish power companies are vulnerable in a situation where they have to survive on a market and where the price is close to the short-term marginal costs of large coal-fired power plants.

9.1.4 Remaining problems, a summary
Table 15 resumes to what extent the second order regulation system (public regulation) succeed in remedying the shortcomings of the internal goal efficiency of the electricity service supply system.

Concluding, one can say, that the public regulation processes have some important successes within the goal ***price-, innovation-, and system*** efficiency. These achievements are very important, and have resulted in a massive introduction of windpower-, cogeneration- and some biogas plants.

The failures have been linked to the goals ***cost-, conservation-, and democratic and competition efficiency.***

With regard to *cost efficiency*, the problem is that the capital costs are too low, due to the methodology of financing new equipment and that the public regulation process is unable to withstand the lobby pressure, when the electricity companies want to invest in new equipment. It is, though, still worthwhile to emphasise that the electricity system as a whole has a general built-in motivation to keep the costs low and a performance showing, that they to a large extent has succeeded with this effort. Nothing indicates that the performance of the Danish electricity system with regard to *cost efficiency* should not be at level with cost performance in other electricity systems in the EU.

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With regard to *conservation-, and democratic* efficiency it also is worthwhile to remark, that the Danish system is well functioning, when compared to the electricity system in other EU countries.

When it comes to *competition efficiency*, the Danish system is very competitive with regard to ability to produce electricity to low prices at a long-term base. However, it has a weakness caused by having no free financial funds, which can be used for survival in shorter periods, where the price at the market is close to the short-term marginal costs.

Goals	Need for public regulation	Public regulation	Remaining problems
(1) Supply security	None	None	None
(2) Price efficiency	Necessary to secure openness with regard to costs and prices and a "non third part profit" regime. **+**	Legislation assuring "non third party profit" assures price efficiency.	None
(3) Cost efficiency	Public regulation in order to avoid excess capacity +	The electricity system can only build new capacity, after accept by the ministry of energy.	The ministry of energy is still not able to assure that excess capacity is not build. Capture problem. +
(4) Conservation efficiency	**+++**	No public regulation introducing "green" tariffs	The tariffs are still supporting consumption increase. Capital in supply system is too cheap. +++
(5) Innovation efficiency	**+++**	Some inclusion of economically independent groups in the planning process	Still too late inclusion of independent groups. Not sufficient proactive. +
(6) System efficiency	**+++**	Legislative support of cogeneration	No system regulation of windpower, cogeneration and consumption ++
(7) Democratic efficiency	**++** Some needs for vitalising the internal democratic processes.	No legislation securing democracy within the electricity system. No systematic inclusion of eco.ind. groups.	Still many problems both within the electricity system and within the public regulation processes. ++
(8) Competitive efficiency	**++** When a market is introduced, it is necessary to establish some capital protection.	No improvements of the public regulation procedures.	Still problems with no free capital.

Table 15: The goal efficiency of the Danish electricity service supply system and its second order governance system

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The cause of the problem within public regulation shown above, is in general, that achievement of the energy policy goals requires the introduction of radical technological changes at the same time as there is a “regulation by negotiation” public regulation tradition in Denmark. Where public regulation has succeeded, it is where this tradition has been replaced by a regulation influenced by the economically independent grassroots groups. Where public regulation has not succeeded, it is where the economically dependent lobbyists such as the old fossil fuel based power producers have influenced it.

The Figure 36 structure illustrates an explanation regarding the connection between the political process and an innovation process changing the electricity supply system from a fossil fuel-based energy system to a renewable energy/energy conservation-based energy system.

It is important to mention two important circles of influence. The “Green” influences cluster around Boxes I, IVb, and III, and the “Black” influence cluster around IVa, I, II, V and VI.

This is always linked to a set of politically defined goals.

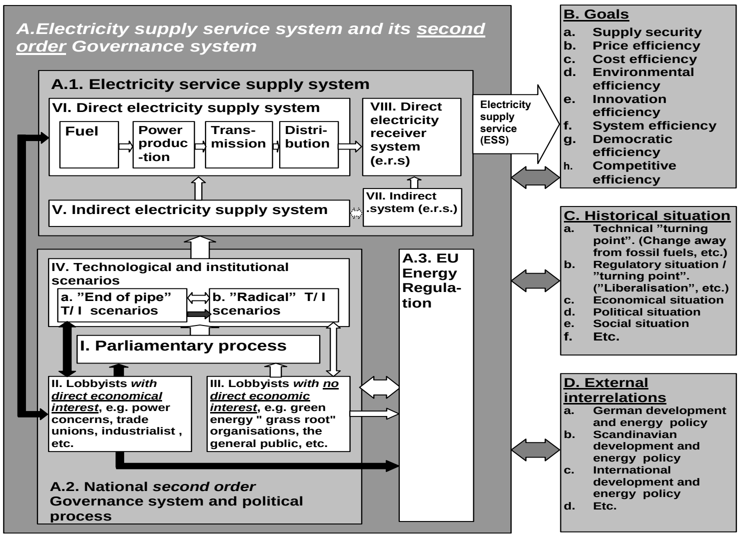

Figure 36. The electricity supply system, and its second order governance system.

When describing the existing public regulation problems, it is important to localise them in the system and dynamics described in Figure 36.

The key words are that there are goals (box B), a historically specific situation of technological change (box C), a division between economically dependent and economically independent lobby groups (box II and III), and a specific dynamics within the cost structure of the established fossil fuel based companies, (box VI). When combining these characteristics of the institutional setting and the historic situation, one starts to get a base telling within which "thinking base" /paradigm, the conclusions have been evolved.

It is worthwhile to remark that if we had not been in a specific historic situation where the goals tell that it is necessary to decrease the emission of greenhouse gasses, having the consequence that radical technological changes are needed, it would not have been important to distinguish between economically dependent and economically independent lobby groups. It is also worthwhile to be aware that this situation is rather new, and the political institutions and the political theory do not yet seem to be prepared to this situation of change.

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The Danish second order governance system has succeeded in establishing some “new corporatism”, where is has opened some doors for the pressure from economically independent groups, but is still dominated by the old corporatism links between the parliamentary process and the old fossil fuel based power system.

The latest development has shown tendencies in the direction of regulation by (negotiated) legislation instead of regulation by negotiation. A law stating the conditions regarding the sale of electricity from auto producers to the public net was accepted in Parliament at the end of 1995. According to the law the power companies are obliged to pay a price for electricity from cogeneration units equivalent to the long term marginal electricity production costs.

The needed technological changes require more initiative by new organisations. It is not possible for the old power companies to develop and introduce these new technologies. New dynamic organisations and organisational models are needed. The regulation, at this stage of the technological development, has to introduce such organisational measures. But so far this has not been done. Whether Parliament will be able to introduce such regulation measures is the big regulation question for the time being.

The character of technological change	The present market regulation	Shortcomings in the present regulation regime
Many internally independent organisations.	- Legislation assuring a rather stable price for electricity sold to the grid. - CO2 subsidy for renewable energy and cogeneration. - Public guaranty for loans invested in district heating systems. - Etc.etc.	- Especially problems with electricity conservation. - Not sufficient free consultancy for the consumers. - Not sufficient regulation of energy tariffs, where the fixed part often increases, making conservation uneconomic.
Technical solutions vary from place to place.	- Network of publicly paid energy offices.	- The network is much to small.
Often the techniques are at an "undeveloped" stage.	- Subsidy to new techniques. - Technical service.	- Overly bureaucratic systems.
Need for regional coordination.	-Regulation possible in the present system, but is still monopolised by the old supply system.	- The existing price and market system does not support the new coordination needs.

Table 16. Radical technological change and problems in the present regulation of the electricity supply system

9.1.5 Proposals for changes in public regulation and the electricity service supply system

These proposals are derived from the analyses of the situation before the electricity reforms in 1999, and can be used as yardstick when analysing the effects of this reform.

The situation has changed. We have a new development at the international scene and we are at a stage of the technological development where a new public regulation paradigm is needed. Together with a detailed knowledge of the existing organisational setting, this has to be taken into consideration, when the public regulation strategies of the future are designed.

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The dynamics of the role of the Danish electricity supply system

The development in the last two decades has shown that the **Danish electricity service supply system** is technologically conservative, inasmuch as it has an inherent need for expansion, in the direction of development towards large central power plants in combination with major expansion of the high tension grids.

The systems employees do not possess the competence to take the initiative to implement technological changes, which would require organisational change in the electricity system. This can be illustrated by the fact that, in the 20 years of the study period, there are no examples of any of the 11,000 employees in the electricity system having opposed the fundamental energy policy attitudes of the systems management.

Initiatives for the introduction of wind generators, decentralised cogeneration plants, industrial cogeneration and electricity savings have all come from outside the electricity system. These initiatives have all been met with opposition from all parts of the electricity system.

However, the opposition has not always been so severe that some of the initiatives could not be implemented. This is caused by a number of conditions in the Danish parliamentary system, and in the Danish electricity systems historical organisation, with consumer ownership, non-profit[62] principles and relative openness on prices and costs. As opposed to the natural gas system, there is no significant confusion between the economy of the electricity supply system and the economy of the public sector, which serves to increase the electricity systems political dirigibility. These very positive aspects of the Danish electricity system should be retained in connection with the implementation of future reforms for the electricity area.

If one is to understand the current pattern of reaction in the Danish electricity system, it must be comprehended as a battle on two fronts. Firstly[63], opposition

[62] It is important to indicate that this is a consumer profit system, in which cost awareness is to the benefit of the consumers by means of the return of profits to the consumers in the form of lower prices.

[63] It is not to be expected that the electricity system is incited to major implementation in any of these fields. It is difficult to believe in an initiative where the electricity savings are of such a volume as to make new generating capacity unnecessary for the next 10 years. Of course there are groups, within the electricity system, that are working seriously and determinedly with electricity saving, etc. However, these initiatives, until further, have not shown themselves to be powerful enough, and the Danish Association of Power Generating Companies has continued, determinedly, to oppose measures

continues against wind generators, decentralised cogeneration plants, industrial cogeneration and electricity savings, on the home market. This opposition swings continually between opposition and, where this does not succeed, take-over. Secondly, the threats and possibilities from relations with PreussenElektra, Vattenfall, Electricity de France and EU regulation changes are intended to be managed.

The electricity systems desire for an expansion of the capacities of the power plants and high tension grids must be seen as a stage in the participation of the Danish electricity system in the struggle/co-operation with the large neighbouring electricity companies, on their technological premises. From the perspective of the power companies, it has been important, that the integrated resource planning did not prevent the construction of a planned 400 MW power plant, Avedøreværket II, which is a part of the co-operation with the large Swedish power company, Vattenfall, or the extension of the KONTEK connection, which is part of the agreement with the German VEAG/PreussenElektra/RWE, electricity companies. A take-over strategy or a practice whereby the electricity system -with the consumer's money - gains a monopoly on electricity conservation activities has been established. In the closed Electricity Strategy Committee, the implementation of the Statute on Integrated Resource Planning has been limited so that the electricity system - with the consumers money – is implementing an electricity saving activity, concurrently with an increase (or at least no reduction) in electricity consumption.[64] Thereby, electricity conservation is controlled in such a way that the Danish electricity system's interest in the construction of new power plants and participation in the struggle/co-operation with the large neighbouring power companies, is strengthened.

At this time, the confrontation on two fronts appears to be the dominating interest within the electricity system, but it is against the current parliamentary energy policy goals. Paradoxically, the new electricity law is, to an increasing degree, making the electricity companies responsible for the further development of renewable energy, especially with regard to windmill parks in the sea.

This combination of inherent resistance against the new renewable energy technologies within the electricity companies, and their increased responsibility

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to convert electrical heating, in 1994 and 1995.

[64] In connection with the argumentation for the new Avedøre II generating station, ELKRAFT assumes that electricity consumption will increase (unless there is public intervention) by 12% over the next 7 years, even though the increase in the last 7 years has only been 3-4%. If the results of the electricity savings, supported by the energy policies, are deducted from this 12% increase, then the result is a stagnation in electricity consumption.

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for the development of these technologies represents an institutional and political time bomb, which makes it difficult to develop and implement solutions which are in accordance with the official aim of reducing the CO_2 emission by 50% before the year 2030.

The environmentally necessary technologies
At the same time we have come to a stage in the technological development at the energy scene in Denmark where it is no longer possible to gain very much by using "end of pipe" solutions. It is no longer possible just to build another **better** power plant, or to clean the smoke. The new technologies are decentralised, and have to be developed, introduced and implemented by organisations, which often do not have energy as their main area of interest.

At this stage of technological development, new infrastructures, organisations, calculation methods, etc., are needed.

The international development
New market regimes are introduced in Europe at present. The actors at the Danish energy scene are increasingly dependent on what is happening in Scandinavia and the European Union. Regulation by negotiation may be increasingly difficult along with internationalisation and the increasing difficulties in identifying with whom the administration should negotiate.

It is in this landscape between changing technological and international conditions, the following proposals should be seen.

The above analysis of the development of the electricity supply system until the year 1999 leads to the recommendations of the following character shown below. It should be mentioned that something very different has happened with the 1999 electricity reform. But it is interesting to discuss which reforms it might have been justified to introduce, and which reforms were introduced in reality. So first the needed reforms are mentioned, and later on the realised reforms will follow.

1) Proposal to reduce the technological conservatism
Internally in the electricity system
Technological conservatism appears to be the result of the election system with a series of indirect elections, which are directed towards strategically designed organisations. Representatives from the centralised power generation technologies dominate ELSAM and ELKRAFT. The negative effects must be changed by means of:

a) Changing the election procedures of the electricity system to more direct elections, and
b) Strengthening of those parts of the electricity system which are independent, and also strengthening of the opportunity for the public to participate in the development of alternatives to the proposals of the electricity technocracy.

In relation to the public administration and the political dirigibility

c) Changing the capital flows within the electricity system so that accumulated capital for large power plants can be used for solutions, which are outside the scope and fantasy of the established power system. In this way, groups which are independent of the present electricity organisation can use their own electricity accumulated funds to construct local solar cell-, windpower-biomass power systems and establish electricity conservation investments, which makes it possible to economise with electricity and the use of fossil fuels.
d) Establish "New corporatism" with committees in the energy administration, which are systematically using the expertise of groups that do not have direct economic interest linked to the energy companies . Representatives for grassroots groups, citizens in a region, etc., establish a system of "New corporatism", where the "lobbyists" from Figure 15, box II, b, are included in the decision process at an early stage.

2) Proposal to maintain the cost efficiency

The cost efficiency and especially the price efficiency appears to be caused by a system with the following characteristics, which should be maintained and strengthened

e) A consumer profits system.
f) Openness regarding electricity prices and electricity generating, transmission and distribution costs.
g) The cooperative ownership organisation, where the consumer representatives, in spite of low election participation, have **rather effectively** represented a desire for cost awareness, especially at the level of the electricity distribution companies. This system should be strengthened by more direct consumer elections.

   These characteristics of the electricity system must be maintained in order to sustain the cost efficiency and the price structure of the Danish electricity system.

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3) Proposal for change from a consumption furthering to a consumption reducing dynamics

- Changes in the direction of progressive electricity prices and capital transference regulations which support electricity saving.
- Abolishment of any fixed price for consumers that have been linked to net systems older than 10 years.

4) Proposals for the strengthening of the democratic process

- At all levels more public access.
- That committees in the central administration have members not only from the old power companies, but also from green organisations, the new renewable energy and conservation technologies, etc. The tradition of negotiations in committees with members from the old power plant companies therefore should be changed.
- That the new law on integrated resource planning should be changed in such a way that groups other than the old power plant companies get access to independent planning resources and investment funds.

10. The Danish 1999 “Liberalization” reforms

Figure 37 illustrates the approach in Chapter 8 and 9 and the present Chapter 10. In Chapter 8 we discussed the goal performance of the electricity service supply subsystem as it was organised until 1999. In Chapter 9 we discussed the goal performance of the combination of this system and the second order governance system as this system functioned in the period up to 1999. We ended up by giving proposals, which could improve the goal performance in some areas.

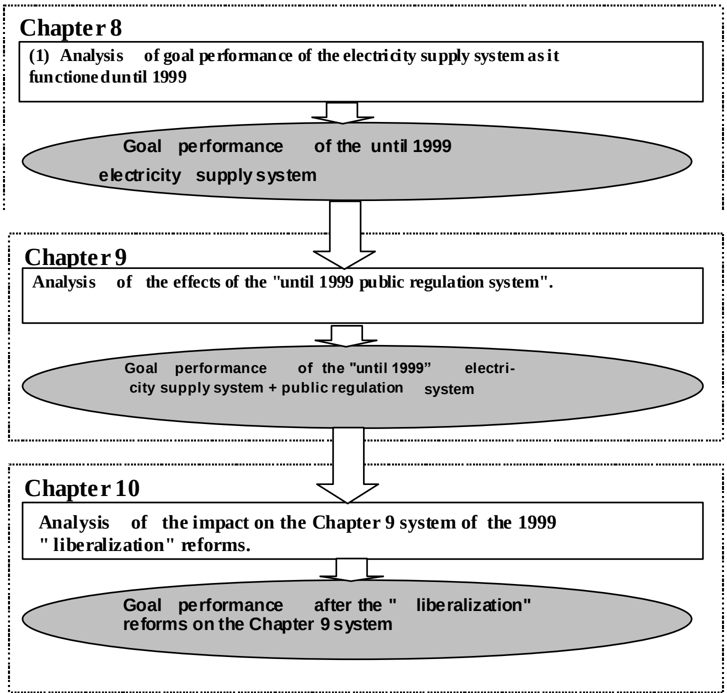

Figure 37. The approach in Chapters 8, 9 and 10

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This Chapter 10 deals with an analysis of the impact of “liberalization” in general and the 1999 “liberalization” reform especially. The aim is to analyse two questions:

a. To which degree the new reform improves the goal performance of the Danish electricity service supply system and its second order governance system.
b. How the dynamics of this system is changed, and how this influences the questions regarding the Figure 5 influences of the development from the German energy system. The “risks” of selling the Danish electricity infrastructure, the influence upon Danish technological innovation at the energy scene, the direct political influence and the market competition influence.

In 1999, a new electricity reform was accepted in the Parliament. In the following, we will describe this reform and discuss whether it is an answer to the needs for reform discussed in the preceding chapters.

The new Danish law regarding the electricity supply system was approved by the Parliament on the 28/5/1999 with a solid majority.

10.1 Background situation

The technical development in the Danish electricity system in the nineties is characterised by considerable technical changes. In this period the wind power share of electricity production rose from 1.2 % to around 10% and the “Decentralised cogeneration” share from below 1% to around 25% of total electricity consumption. The share of electricity coming from large coal fired power plants decreased from close to 100% in 1990 to around 60% in 1999.

The situation is characterised by an energy policy in the nineties, which allowed both capacity increase in the green technologies, wind power and decentralised cogeneration, and in centralised coal based capacity, resulting in a considerable increase in power production capacity without a corresponding increase in electricity consumption. In 1999, the total installed power plant capacity was 10570 MW (Exc. 1500 MW wind power), and the consumption 32.5 TWh. These 32.5 TWh could, if each MW effect produced 4000MWh/year, have been produced by means of a capacity of 8130MW.

The excess capacity in the Danish electricity system, therefore, can be estimated to be between 2000 and 3000 MW around 2000.

So the technical situation at the Danish electricity scene had, at the end of the nineties, the following characteristics:

a. A recent increase in the wind power proportion to 15% of the total electricity consumption.
b. A recent increase in the proportion decentralised cogeneration based electricity to 25% of the total electricity consumption.
c. A recent decrease in the coal based electricity production from close to 100% to a little above 60%. This is resulting in a situation where rather new coal-fired power plants are running at very low production, and where the average utility factor is around 3000 hours, meaning, that the coal-fired capacity is producing in average 3000 MWh/year pr installed MW capacity. This surplus capacity already in 1996, before finishing 800 MW capacity at Vendsysselværket and in Skærbæk, made it possible to export 7TWh electricity in 1996.
d. A considerable excess capacity amounting to around 30% of the installed capacity (excluding wind power).

This situation naturally has a lot of influence upon the succeeding liberalization, as Denmark adds a large contribution to the situation of excess capacity in Northern Europe.

The 1999 electricity law from May 1999

This introduced a system of changed regulation within the following areas:

1. Changed regulation of the existing direct electricity service supply system consisting of:

a. Market opening before 1/1/2003, so that all consumers have the right to buy electricity, wherever they want to.
b. The establishment of a new organisational structure.
c. CO2 quotas: 23 mil. Tons in 2000, 22 mil. Tons in 2001, 21 mil. Tons in 2002 and 20 mil. Tons in 2003. If the power companies exceed their quotas, they will have to pay a fine of 40 DKK/ton, or around 3.5 øre/kWh.

2. **The establishment of energy conservation legislation**.
3. **A new "double market" regulation of "green technologies"**.

a. The introduction of "Green Certificates" and a market for renewable energy, together with the goal of 20% renewable energy based electricity from the total electricity consumption, before the end of 2003.
b. The base price of renewable energy determined on the "market", i.e. Nordpool.

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10.2 The changed regulation of the existing direct electricity service supply system and its impact upon cost and price efficiency

It is worthwhile to mention that the Danish direct electricity service supply system in 1999 had a very good price efficiency, and a combination of price- and cost efficiency which made the Danish system provide the lowest electricity prices in EU including Sweden and Finland for industrial consumers using less than 1 mill. KWh/year. There were, however, indications that the Danish system, in specific situations like the one in the nineties where a "liberalization" was in the horizon, could result in the establishment of excess capacity. The question here is whether the 1999 "liberalization" is able to solve this (minor) problem regarding a tendency to develop excess capacity while not destroying the high price efficiency of the system.

10.2.1 The establishment of a new organisational structure

A distinction is established between:

- p*ower production companies*, which, in the future, will be stock-profit driven companies with an obligation to continue to deliver heat to the cities,
- *system operator companies (at present two)*, which will be monopolies, and have the obligation to manage the transmission networks and coordinate the whole electricity system within their region, and
- *net distribution companies*, which will own and manage the distribution networks and continue to be monopoly companies in the future,
- *electricity supply companies*, which have the obligation to supply electricity to all the consumers in their supply area,
- *electricity trade companies*, which is any company that wants to trade electricity, and are allowed to earn a profit.

In the year 2001, the common ownership structure is that the *consumer owns the power production companies.* Meanwhile, the door for sale to other owners has been opened by the 1999 reform. Especially the fact that they now are allowed to gain and accumulate a profit, is a necessary precondition for a later sale. A sale of parts of the power companies is a probable scenario, as the ongoing very strong merger movement between electricity companies all over Europe might make it very tempting for the "director level" management groups in the Danish power companies to enter so called "strategic alliances" with, for instance, Vattenfall, E.ON. Energie (former PreussenElectra and Bayernwerk). In practise, exchanging ownership shares typically results in this.

In the case of sale, any surplus should be returned to the owners/consumers. But the sales price might be too low, if the influence from the consumer representatives is too weak.

Power companies have the obligation[65] to continue deliverance of district heat to their heat markets in the big cities at prices that are not exploiting a monopoly position (§75 stk.2 in the 1999 electricity law). The power companies shall also meet the CO2 quota, which is stipulated each year by the Parliament.

The *System operator companies* are still owned by the consumers. At present there are two such companies, namely ELTRA in Jutland-Funen and ELKRAFT on Zealand.

They own and operate the transmission network, and have the obligation to secure that the total system functions with regard to capacity and technical quality of the electricity. Furthermore, they must secure that the *prioritised* electricity production (renewable energy and cogeneration) is sold and distributed proportionally[66] to the consumers. The company also should pay for this prioritised electricity to the producers and collect the payment from the consumers. The system operator also has an obligation financially to support the development of new electricity conservation and renewable energy technologies.

More than 50% of the executive body should be elected by the consumers in the supply area of the system operator.

The system Operator Company and the transmission network can be sold, but the State has the right of pre-emption within three months from the moment, when a bid from a buyer is known. The State must pay a price according to "usual market conditions". Here it should be stated, that it is very difficult-if not impossible- to define usual "market conditions" in a situation where there are only very few potential buyers. If the State does not use its

[65] It is not possible to force power companies to deliver heat to the large cities according to the hitherto price policy, where the heat consumers just pay the marginal extra costs, which, on a power producing coal-fired plant selling electricity to the long-run marginal costs, can be allocated to the extra activity "heat production". So if the power companies cannot sell the electricity from the cogeneration plants at the market for a price, which in average is equal to the long-term marginal costs of electricity production at a large coal-fired power plant, it will nevertheless be necessary to rise the heat price in the large cities.

[66] Any consumer is obliged to buy a certain percentage of prioritised electricity.

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option within a three months period, it looses it.

A “reasonable profit” can be returned to capital owners, linked to the amount of physical assets needed for the activities of the system operator § 69 in the 1999 electricity law. The estimation of the value of the fixed assets is done in an opening balance at 1/7 2000 (Kragelund, 2000). The following years the value of the fixed assets will be estimated by means of usual accountancy principles.

There are 104 *Distribution net Companies* out of which 45 are owned by the municipalities, 40 are consumer co-operatives, 11 self-governing institutions, 7 partnership owned, and 1 a limited company. They own and operate the distribution network and secure the technical quality within the network. According to the 1999 law, they are also obliged to give energy conservation advice and to further electricity conservation in their area. The consumers in the supply area must elect more than 50% of the executive committee. The company can be sold, but there are rather strict rules controlling the profit, which can be extracted from the company.

The owners can extract a “reasonable” profit as return on the investment share contributed. This does not mean that a profit share related to any share “purchase” automatically can be extracted. The basic principle regarding price policy is that the company can cover costs plus a reasonable payment to the investment share contributed. The rate of return is calculated on the base of a making up regarding the value of the necessary fixed assets, and will be around 7% in interest.

The estimation of the value of the fixed assets is done in an opening balance at 1/7 2000 (Kragelund, 2000). The following years the value of the fixed assets will be estimated by means of usual accountancy principles.

The electricity *supply companies* are initially the same as the Distribution net companies. They are achieving concession from the State for a period of five years, and must with regard to accounting, be separated from the distribution net companies.

Their main obligation is, within a specific region, to supply electricity for reasonable prices and conditions to any consumer who might want it. And furthermore to organise the accounting and payment procedures related to help fulfilling the consumer obligation to buy a specified proportion of prioritised electricity. In this connection they also are supposed to organise the system of “Green certificates” for renewable energy, when this is established around the year 2003. Supplying electricity conservation counselling also is one of the obligations of the supply obligation companies.

At least the consumers must elect 30% of the members of the board.

The company can be sold.

The basic principle regarding price policy is that the company can cover costs plus a reasonable payment to the investment share contributed. The rate of return is linked to an account rendered regarding the value of the fixed assets, and will be around 7% in interest.

Electricity trading companies can be any company that wants to trade with electricity. They have the right to use the transmission- and distribution networks, when paying according to the rules described in the 1999 electricity law.

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In Table 17 the above information are resumed.

	(1)Point of departure ownership	(2) Ownership Restrictions	(3)Profit Restrictions	(4)Public Service Duties	(5)Other Restrictions
(a)Power production companies	Consumer ownership.	None.	None.	Heat supplies obligation. Price control for heat prices.	CO2 quotas.
(b)Distribution net companies	Consumer ownership.	At least 50% consumer ownership.	Reasonable profit linked to estimation of fixed assets.	Obligation to organise payment for renewable energy etc.	Establish standard "articles of association".
(c) Electricity supply companies	Consumer ownership.	At least 30% consumer ownership.	Reasonable profit linked to estimation of fixed assets.	Obligatory supply of electricity and PSO service. Organise payment for renewable energy, etc.	Establishment of standard "articles of association".
(d)System operator companies	Consumer ownership	At least 50% consumer ownership. Public representation in board.	Reasonable profit linked to estimation of fixed assets.	Obligatory supply security for the whole system.	Establish development program for "green" technologies.
(e)Electricity trade companies	None.	None.	None.	None.	None.

Table 17. A summary of the organisational and ownership part of the Danish electricity reform

By the 1999 electricity law it is stated that disputes are resolved in the electricity supervision committee, to which six members are designated by the Minister of Energy.

10.2.2 The degree of market competition in the 1999 electricity law

One of the main aims of the new law is to establish increased competition in the electricity service supply sector. In order to analyse this question, it is worthwhile to go back to our discussion regarding the value-added chain in this sector, as described in Figure 8, and combine it with a description of the regulation changes being introduced by the 1999 electricity reform. This combination is seen in Table 18.

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"Liberalization" Dimensions	1. Fuel system	2. Direct Electricity supply system			3. Indirect eletr. system	4. Consumer level
		2.1.Power production	**2.2. Transmission**	**2.3. Distribution**		
(a) Value added as % of Direct Danish Electricity Supply System	**26%**	**9.3%**	**3.4%**	**14.6%**	**46.7**	**100**
(b) Buyers Power, Price competition	No general reforms in order to remove subsidies.	**- Access to buy from any power producer**.	-Obligation to transmit at fair prices. -Natural ***monopoly.***	-Natural ***monopoly*** on "net services". -Less price information.	No reforms	No control regarding consumer cartels.
(c) Ownership Power/competition.	No reforms.	-No efficient monopoly control. -100% can be sold. - As 2.2.c.	-No division of ownership between power production, transmission and distribution. - State "option".	-No max. Size for distribution companies. - 50% to 70% influence and assets might be sold. -As 2.2.c.	No reforms	No control regarding consumer cartels.
(d) Parliamentary power	No reforms.	Concession system.	- Public representation in the board of the "system responsible" company.	-Introduction of state cost control (Bench marking) -Public Service Obligations.	No reforms	- Conservation linked to Distribution comp. No independent conservation agents.
(e) Access to public grid. Barriers to entry removal.	As 2.2 c.	-Close to monopoly with regard to regulatory services.	monopoly with regard to deciding the type of, and agent for regulatory services.	-Free use of the distribution net. Fair payment.	No reforms	-No policy against monopolistic electricity tariffs. etc.etc.

Table 18. The "liberalized " sections of the direct and indirect electricity service supply system.

How to read the table? When the consumer buys electricity for 100 DKr, 26% goes towards fuel, 46.7% to the indirect electricity system and the rest, 27.3%, to the organisations/people managing the production chain, power companies, transmission grid and distribution system.

Only the black/grey part in Table 18, power production, ***or in this case 9.3% of the total value added chain, is liberalized*** in the sense that the consumer can select between different power producers. Consumers still have to use the "one set" of distribution and transmission cables. *The distribution and transmission systems thus here, as everywhere else in the world, remain monopolies.*

Furthermore, as it can be seen from the above table, the "liberalization" dimension of the Danish 1999 electricity reform, as well as the liberalization reforms in the electricity sector of other countries, only deals with liberalizing the direct electricity supply sector. There are no reforms dealing with fuel procurement, which could have been the case as a part of the EU collaboration. There are no reforms dealing with the indirect electricity system, or dealing with competition between power cable-, power plant- solar cell- and wind generator producers, although equipment, in the case of coal-based technology, amounts to almost 50% of the electricity prices. A percentage, which will increase when windpower and solar cells get a larger share of the electricity markets.

If we regard liberalization as a method to increase consumer influence over a production system, this can be done by means of the three lines shown in Figure 31, consumer power through the Parliament, through the market and through consumer ownership control.

The Danish electricity supply system still has consumer ownership control, but the door has been opened for changes in this area. The power plants and large parts of the network and transmission companies might be sold to shareholding companies or other electricity companies. If this happens, the Danish electricity supply system risks losing its consumer control or moving from a consumer ownership type of political liberalization to a shareholder ownership type of oligopolistic "liberalization" such as in the UK. In that case, it is most probable that the cost and especially the price efficiency of the Danish electricity supply system will considerably decrease.

So with regard to price and cost efficiency, the Danish electricity consumers cannot expect any improvements. Rather they can expect price increases, and a new price structure making smaller consumers pay relatively more per

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kWh than large consumers, as they already do today. This is what will probably happen, despite the fact, that cheaper and more cost efficient electricity production was the main argument behind the reforms.

All the reforms are only dealing with the "Direct Electricity service supply system" which amounts to around one quarter of value added contained in the Danish electricity price.

Regarding Buyers power:
The transmission and distribution net services are almost 100% natural monopoly services in the Danish consumer profit system. There is no windfall profit to any stockholders, which could be decreased by means of increased competition. The value-added share of the electricity price, therefore mainly are net services.

Both the transmission- and distribution net services *will continue to be area monopolies.*

Therefore, what is left for price competition in the Danish system is the power companies, being responsible for around 10% of the electricity price.

Regarding Ownership power/competition
From a legislation point of view, it is now possible to sell the power companies to anybody, and the power companies are allowed to get a profit. The road is open for the establishment of stock ownership by others than the electricity consumers. Still the motivation for selling might be weak, as any profit should be distributed between the consumers, and sale should be approved between the consumerss representatives. This means that it is not as easy to sell consumer owned power companies, as it is for a government to sell its state owned companies. Many of decentralised decisions have to be made within the democratic institutions of the electricity companies. Furthermore, the excess capacity in the Danish power system at present has no high value, as the CO2 quotas makes profitable export difficult.

Nevertheless, it is a possible scenario that the professional directors of the power companies will be able to convince the democratic assemblies of the electricity companies that it is a good idea to sell, for instance, 30-50% of the power companies in order to establish strategically partnerships with other large actors at the market. The professional leaders within the power companies might have an interest in this development, as it would weaken competition and establish a stabilised market situation. It is much more difficult to localise any interest seen from the consumer viewpoint, as a weakened competition results in higher consumer prices.

Concluding, regarding consumer ownership control, this control has been decreased by the reform, as it is now to an increased extent possible to sell the property rights to non-consumer capital interests.

Parliamentary consumer power.
There is public representation in the board of the “system responsible company”, which also handles the transmission system.
The openness regarding costs and prices has been decreased in the whole system.

In general, no increased openness towards the public has been introduced.

State “Bench marking control “ has been introduced towards the distribution companies. So now we are in a situation where the costs in a privately consumer owned system is not only controlled by the owners representatives, but also by the state authorities, which are now controlling that the consumers are not cheating themselves.

10.3 Comparison of the new Danish and the new German renewable energy governance systems

In the 1999 Danish electricity reform the "political price-/amount market" system was replaced with a "political amount-/certificate price market" model. All wind turbines contracted before end 1999 were secured a political fixed price for the produced electricity, whereas wind turbines contracted after this date were paid according to the new renewable energy governance system. In this system the price consists of two elements, of which the first is the normal spot market price at the Scandinavian Nordpool electricity market, and the second a price on green certificates determined upon a market for "green certificates". This system is supplemented by a political quota, where the consumers are obliged to buy a certain percentage of their electricity consumption from renewable energy technologies. This quota is defined some years ahead. The system is planned to be implemented in the year 2003.

Here we will compare this new Danish renewable energy governance system with the new German renewable energy governance system.

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(a) The *new German* is a “Political price-/amount market[67]” model, which has politically set prices for RE (Renewable Energy) electricity, and where the produced quantity of RE electricity is determined on the market; and:

(b) The *new Danish* system is “Political quota-/certificate price market[68]” model, where the RE electricity quantity is politically fixed as a quota and the RE electricity prices determined on the market.

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The “Political price-/amount market” model has been successful in Germany, Spain, and Denmark, countries that boasted around 80% of the European wind power production in 2000.

In 1999, the Danish Parliament approved a law introducing a "Political quota-/certificate price market" model for RE. Wind turbines contracted from 2000 and onwards are subdued to payment according to these not yet totally settled rules. Almost no contracts have been entered into under these rules, which have brought the Danish wind power development to a very critical situation. Only offshore wind turbines are build, as they are subdued to specific "demonstration project" subsidies and payment rules. The wind power boom (660 MW) of 2000 was contracted before 31/12 1999 and based on the old "Political price-/amount market rules", which were in effect until this date.

In 2000, the German Parliament approved a new advanced "Political price-/amount market", and in 2001, the French Parliament accepted a similar model. Recently, the EU commission accepted the use of the "Political price-/amount market" model in the latest Directive proposal[3], which has been accepted by the Council of Ministers. This keeps the question of the future regulation framework open. The “Political amount-/certificate price market" model, therefore, is no longer ‘the only possible future regulation model’. This development has lately been supported by a European Court adjudication[69], which says that the German "Political price-/amount market" model is not to be regarded as illegal state aid, and is therefore acceptable as a way of regulating RE development.

[67] The price is politically determined, and the RE-electricity amount is determined on a market.

[68] The amount (quota) is politically set and the price is partly determined on the market, ‘partly’ only because the price in the new Danish "Political quota-/certificate price market" system can only oscillate between a politically determined minimum and maximum.

[69] 13 March 2000: Judgement of the Court, Case C-379/98.

The main arguments for introducing a "Political quota-/certificate price market" system have been linked to the belief that a system with quota regulation and a price regulated on the market would increase competition between suppliers of RE and result in getting more ‘value for the money’ of RE. Upon examining the various arguments and the dynamics of the debate, it is striking that there does not seem to be any thorough discussion on the fact that, compared to fossil fuel technologies, RE technologies are characterised by:

a. Having a cost structure with a very high percentage of investment-fixed costs and very low running costs, which implicates high investor risks on the market and an increasing importance in keeping the competition at the equipment market alive.

b.Having different natural resource bases from location to location, a factor which makes it necessary to establish a governance system that furthers an EU-wide "site efficiency"[70] *generating process rather than a " mono price" (one price on a European market) based price competition.*

c.Being dispersed around the country, and often in residential areas, which makes it particularly important to involve neighbours and people from the region in the design, development and ownership of RE projects.

d.Being newcomer technologies, thus having minor market shares and meeting resistance strategies from established technologies.

The "Political quota-/certificate price market" model is no longer ‘the only possible future EU renewable energy regulation framework’. The arena is open. The "Political price-/amount market" model is a better governance model for any country, as well as for the EU, especially because it is well adapted to the above four specific demands to a RE regulation framework.

Which governance model is a market model?

Before entering a discussion of the above four specific characteristics of renewable energy development, it is necessary to briefly discuss the "ideological question" regarding the "market" attributes of the two models.

[70] By "site efficiency" is meant efficiency with regard to the exploitation of a specific regional renewable energy resource.

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The "Political quota-/certificate price market" system, with its politically set quantities (quotas), has persistently been marketed as more ***market-oriented*** than a "Political price-/amount market" system with politically fixed prices and quantities determined on a market. This delusion has been so successful that it is now an almost undisputed 'fact', that "Green Certificate" trading on the basis of a market plus quota regulation should be 'the genuine market' system.

Table 18 illustrates why this is a delusion.

	"**Political quota /certificate price-market**" model (Danish model from 2003)	"**Political price /amount market"** model (Present German, Spanish and French model)
Price determination	**Market and Political**	**Political**
Amount determination	**Political**	**Market**

Table 18. Political and market determination of price and quantity in two regulation models

Comment: *The price in the Danish "Political quota-/certificate price market" model is partly politically defined, since the law determines that the price should not be below 1,32 EUR/C/kWh or above 3,57 EUR/C/kWh.*

As illustrated in the table, the "Political quota-/certificate price market" model shows the political interference on the market at the quantity as well as at the price levels in the Danish case. The only political intervention in the "Political price-/amount market" model is at the price level.

The "Political quota-/certificate price market" model, therefore, is not more liberal or market- oriented than the advanced "Political price-/amount market" model. On the contrary, the Danish "Political quota-/certificate price market" model, due to its 100% State-governed amounts, and partly State-governed prices, was closely related to the governance frameworks of former East-European planned economies until around 1990.

The high fixed cost RE characteristics

(The "political quota-/certificate price market" system is "liberalizing" a dwindling market and "bureaucratising" a growing market)

In a "Political price-/amount market" system, the wind turbine factories are able to decrease their selling prices, resulting in an increased sale of wind turbines. It is due to this system that the wind power cost pr. kWh has decreased by 80% since 1980. In a "Political quota-/certificate price market" system, the quantity of wind power is politically decided several years ahead. Consequently, the wind turbine producers, as a group, can only increase their turnover by increasing prices. This motivates the wind power firms to establish "strategic collaboration" or mergers, in order to achieve increased market control. This mechanism constitutes an important problem as one of the general structural changes on the market. The *decrease of value added on the market for electricity and the likely increase of value added on the market for energy equipment*, seen as a proportion of the sales price at the consumer level.

Concretely, the change to some types of RE systems, such as wind power, *represents an automation of electricity production*, with 85-90 % as investment costs and the rest as maintenance costs. Once the wind turbine is built, hardly anybody works on it. It just produces electricity for 20-30 years, and is usually maintained by service units linked to wind turbine factories. Therefore, the wind turbine will not work more efficiently because of competition with other wind turbines on the electricity market. In a traditional electricity service supply system, the situation is totally different. At least in theory, one might expect that market competition on the electricity market might put pressure upon the power utilities, which will then dismiss some of the people employed at the power plant. A wind turbine can dismiss nobody, once it is built. Any potential personnel compression can then only happen at the level of the wind turbine factory, because a wind turbine is, in principle, an energy automaton.

At present, fossil fuel back-up systems are still being used. But in the future, a system with different types of storage techniques, such as hydrogen storage, might be developed. These systems also appear to be “automatic storage systems”, which hardly require any maintenance performed by employees in an energy organisation.

Thus, when introducing renewable energy systems, the market for electricity is decreasing in importance, whereas the market for energy equipment is becoming increasingly important.

In Table 19, the relative importance of the market for equipment is compared within a fossil fuel system and a renewable energy-/electricity conservation system.

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	Equipment market	*Electricity market*
Fossil fuel systems	47%	53%
Renewable- and electricity Conservation systems	81%	*19%*

Table 19: moving from fossil fuel to RE means a change in value added from the electricity market to the equipment market

In the present situation of technological change, the "Political quota-/certificate price market" system ends up introducing price competition on a dwindling market and abolishing market competition on an expanding market. The advanced "Political price-/amount market" system supports market competition on the growing market for equipment, and, therefore, is especially well suited to the present period of technological change.

Different natural resources base from location to location

As mentioned in the beginning, renewable energy technologies are characterised by having different natural resource capacities from location to location. A wind turbine on an inland site in Germany only produces around 50% of the quantity produced on a very good coastal site in Ireland or Scotland. When dealing with nuclear-, natural gas- or coal-fired power plants, variations from location to location will mainly depend on differences in cooling facilities, with a coastal site being slightly cheaper than an inland site that needs cooling towers.

Due to the declared EU goal[71] of increasing the percentage of RE based electricity production (not including large hydro) from 3.2 % to 12.5 % during the 1997-2010 period, it is necessary to not only exploit the best coastal sites for wind power. It is also necessary to use good inland wind sites all over Europe. With a "Political quota-/certificate price market" system for EU, there would be only one certificate price for wind power in the EU.

Regarding wind power, Figure 38 shows the different production prices in a "model union" consisting of three case countries.

[71] See Annex 1. in Draft directive of the European Parliament and of the Council on the promotion of electricity from renewable energy sources in the internal electricity market, Dec. 2000.

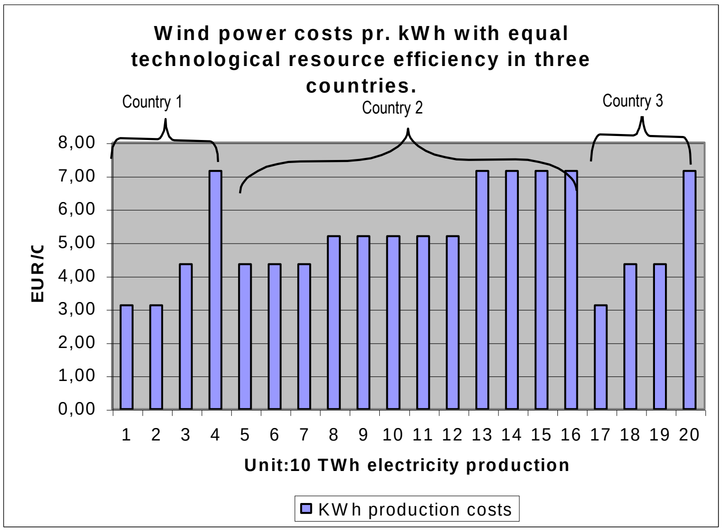

Figure 38. Wind power production costs in the three countries
Source: "Renewable energy governance systems" Frede Hvelplund, July 2001.

The costs of producing wind power vary from around 3 EUR/C/kWh on a very good coastal site, in Ireland for instance, to around 7 EUR/C/kWh on good inland sites in central Europe. As wind power production on inland sites is required, and there is only one marketplace and one price for “Green Certificates” in Europe, the price level needed in order to produce wind power on inland sites, especially in Central Europe, will be at around 9 EUR/kWh. This price is required because some profit is necessary to stimulate investment. This price would result in very high profits on the good wind sites, with between 90-160% profits on the good (classes 0 and 1) sites. Hence, the problem of establishing a mono-price market for renewable energy in the EU.

RE resources and the "Political quota-/certificate price market" model
In the "Political quota-/certificate price market" model, a quota politically regulates the amount of RE –electricity. The price is determined on a market for electricity.

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In Figure 39, the three countries have introduced a common "Political quota-/certificate price market" system. Linked to their different wind resources, this governance system entails the following wind power cost functions and profits for wind site- and wind turbine owners:

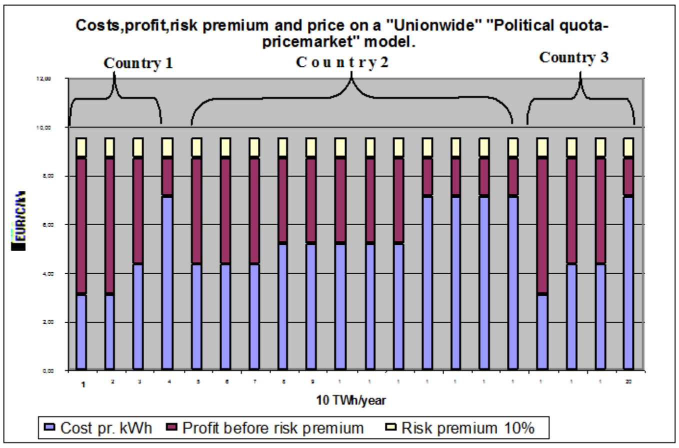

Figure 39. Costs, profits and prices in a union wide “Green Certificate” market (case example)
Source: Same as Figure 38.

(**Assumptions**: 10% risk premium due to fluctuating prices. 20% profit demand on a wind class 3 site.)

The figure shows that on this market, there is one price for wind power all over the Union, namely the one developed in the EU certificate market[72]. The assumption is that politicians have established a quota system that ensures that an annual production of 200 TWh RE-electricity is implemented. In order to reach this TWh goal, it is necessary that the kWh price on the market is at least high enough that it becomes profitable to use wind class 3 sites, which concretely translates into a price slightly above 8 EUR/C/kWh. Additionally, the fluctuating prices on the certificate market imply that the investors demand a 10% risk premium, increasing the price to 9.8 EUR/C/kWh.

[72] In order to not complicate the argument, we assume that the basic price for electricity, and the ‘Certificate price’, is the same in all three countries.

RE-resources and the advanced "Political price-/amount market" model

We call the model "advanced" because of its ability to foster a competition process, which increases "site efficiency" in a non-bureaucratic way[73]. In Figure 40, the effects of this type of regulation are illustrated.

Cost and price efficiency of the advanced "Political price-/amount market" model

The price performance of the advanced "Political price-/amount market" model is shown in Figure 40 for the three countries. The figure displays exactly the same cost structure as in Figure 38 and 39. The only difference is that the advanced "Political price-/amount market" model has a politically defined, site dependent price framework, which makes it possible to decrease the profit on good wind sites without destroying the economy of inland wind sites.

[73] It is worthwhile mentioning that the UK tendering system could, in theory, be called an ideal system, in the sense that it potentially fosters the pursuit of site efficiency in a detailed way, as the auction is linked to a specific wind site. Meanwhile, unfortunately, the UK system seems too bureaucratic and unable to ensure sufficient wind power capacity. The advanced "Feed in" system might secure site efficiency without the bureaucratic disadvantages of the UK system.

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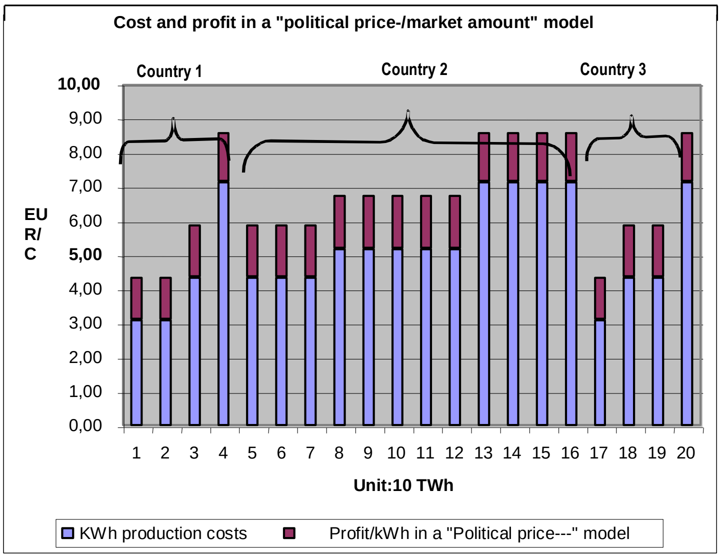

Figure 40. Price, profit and costs in the "Political price-/amount market "model (Case example)
Source: Same as Figure 38.

(**Assumptions**: *Profits are a percentage of costs: 40% on wind site 0; 35% on wind site 1; 30% on wind site 2 and 20% on wind site 3. These profit percentages are approximations of the profits that we have calculated on the basis of the new German prices. Since prices are politically guaranteed, there is no need for any risk premium.)*

Renewable energy is "dispersed" and often close to residential areas
One of the main historical secrets behind the Danish wind power success was that a system of co-operate neighbour and local ownership was furthered by the public regulation, resulting in more than 60,000 wind turbine owners in Denmark. People like wind turbines, when they own them, and are not annoyed by the noise and visual inconveniences, especially when getting a fair compensation. However, with a system of distant utility, or shareholder owners, the local inhabitants are only getting the disadvantages without any compensation. This is seen as unjust and results in increasing local political resistance against wind power. It is as simple as that.

The new Danish "Political quota-/certificate price market" system results in very fluctuating prices due to a range of different factors. The cost structure of wind turbines results in a very vertical supply curve. Once wind turbines are built, they will not close down production, as the majority of costs are fixed. Annual wind resources vary with up to 30%, making it impossible to govern by quotas, as the annual change in wind resources will surmount the size of a quota increase. Furthermore, the market will be characterised by large actors who will have the ability to manipulate market prices. Altogether, this causes the certificate prices to fluctuate heavily and often in a manipulated way, making it impossible to draft trustworthy wind power project budgets. Consequently, the old procedure of financing a wind turbine project together with the local bank is no longer possible. Only large financial investors and power utilities are left over in the market. This means that the number of investors and, consequently, the competition between investors is decreasing, resulting in higher project prices. Furthermore, it results in increase local and regional political resistance against wind power.

Characteristics of "newcomer" technology

The competition between renewable energy technologies and existing fossil fuel and uranium based power companies is very often a win/lose situation. If wind power production increases, then the profit of the power companies, ELSAM, in Denmark, EON in Germany, etc., decreases. Due to excess capacity linked to these existing power companies, RE technologies are, when owned by these companies, often competing with the short-term marginal costs within these companies.

Hence, these old fossil fuel and uranium based companies do not have real economic interest in investing in RE plants. Consequently, it is important that the politicians are establishing development tracks, where independent investors not having "sunk costs" can further the renewable energy technologies linked to the old fossil fuel and uranium technologies. As described above, the "political quota-/certificate price market" system tends to hamper the possibilities of such independent neighbour and local investors. This governance system, therefore, is leaving the economically unmotivated uranium and fossil fuel utilities alone in regard to investments in the RE market. This is not the case with the "Political price-/amount market" system, which, with its foreseeable prices, makes it possible for independent "neighbour and local" investors to establish wind turbine projects.

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Concluding remarks

The "political quota-/certificate price market" system introduces an inefficient competition between energy robots, and weakens the increasingly important competition between equipment producers. It hampers the competition between investors by making it difficult for neighbours and local investors to invest in wind turbines. Due to its mono price character, it gives too high profits to wind turbine owners at very good wind sites, and not high enough to wind turbine owners at poor wind sites.

The "political quota-/certificate price market" system is very far from being a market model, as the RE amount is politically decided and the certificate market price is also political influenced.

Table 20 summarises our conclusion.

	"Political price-/amount market " model	"Political amount-/certificate price market" model
(a) Is it a market model?	The price is political; the amount is decided upon a market.	The amount is political; the price is partly decided upon a market, partly politically set.
(b) Is it furthering competition between equipment producers?	The equipment producers as a group can expand sales and profit by lowing production costs.	The equipment producers are facing a 6-8 year politically set annual production quota. They can expand profit by lowering costs and especially by increasing sales prices.
(c) Can it differentiate the price between good and bad wind sites?	Yes, as it is done in the German model.	No. In this "mono-price" model, the same price is paid to the very good coastal sites, as to the good inland sites.
(d) Can it price differentiate between the first and last years of the production of a given RE plant?	Yes, as it is done in the German model.	No. The same price has to be paid during the whole lifetime of a RE plant.
(e) Can it lower the price in parallel with RE productivity improvements?	Yes, as it is done in the German model.	No. The quota has to be set for a 6-8 years period, and new improved wind turbines are getting the same certificate price as less efficient wind turbines built at an initial stage of development.
(f) Does it support neighbour and local investors?	Yes. The foreseeable prices enable local groups to get loans from the local banks.	No. The very fluctuating and possibly manipulated prices make it too risky to invest, and difficult to get loans from the local banks.
(g) Does it put a cost pressure upon equipment producers?	Yes. Almost the same cost pressure on investors at good wind sites as upon investors at inland wind sites.	In general, no. The mono-price system gives very high profits to owners of good coastal sites. This increases site prices and weakens the cost pressure upon equipment producers.
(h) Does it support independent investor groups?	Due to the above (f), yes.	Due to the above (f), no.

Table 20. A comparison of the "political price-/amount market" model with the "political amount-/certificate price market" model

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The conclusion, therefore, is that it is time to find a RE governance model that considers the specific needs and characteristics of RE technologies. The present analysis strongly indicates that a "political price-/amount market" model in this connection is far better than the "political quota-/certificate price market" model.

Furthermore, a common EU model, based on the principle of site efficiency, would be much more flexible, cheaper and easier to pursue than the "political quota-/certificate price market", or mono price model, which is designed for uranium and fossil fuel technologies, and represents a governance model designed for the technologies of yesterday.

10.4 CO2 quota and tradable permits regulation

As a part of the electricity reform, the Danish power companies have got a CO2 quota of 23 mil. tons in 2000, decreasing to 20 mil. tons in 2003. If the power companies exceed the emission quota, they will have to pay a fine of around 0.46 EUR/C/kWh. In 1999 and 2000, where the prices at the Nordpool spot market were are close to the short run marginal costs, that is between 1.32 and 1.6 EUR/C/kWh, this fine will inhibit production above the quota from these plants. But as soon as the prices are just above 2 EUR/C/kWh, as they have been the first half of 2001, or still well below the long-term marginal costs excluding external costs, the Danish power companies will produce and sell coal-based electricity, even when having to pay the 0.46 EUR/C/kWh in CO2 fine.

This illustrates the problem of giving a free of charge CO2 quota to established fossil fuel companies, and establishing fines which are well below the difference between the short term and long-term marginal costs of coal-based electricity production.

The way firms are described in the theory behind the arguments for a tradable permits system leads to the conclusion that it is, as it is done in the 1999 Danish reform, economically optimal to give old fossil fuel actors free pollution quotas linked to their historical pollution level. Firms are described as **“dots”** with no internal organisation life, and with no difference in the internal political and economical incitement mechanism between an established power company owning large coal-fired power plants, and a newcomer organisation wanting to build a new renewable energy plant.

These firms are all viewed as identical **“dots”** with the following characteristics:

- Having the same pollution abatement costs. The costs and value of production of a windmill is the same within an organisation producing coal- or uranium based electricity as in a firm, which is independent of coal and uranium.
- Having the same organisational dynamics and relationship to the outside world.

It is when these identical **"dot firms"** meet each other on the market, that the "curve exercise" with marginal cost-, supply- and demand curves can then get started, as discussed in Section 5.4.

The conclusion usually is that it is economically optimal to give a certain amount of CO2 permits freely to the actors, according to their historical pollution levels/emissions. The historically biggest polluter will consequently get the largest pollution quota as a present from the public. The argument is that such a system will not meet heavy political resistance, as the strongest potential opponents will get the largest gifts. This final conclusion is true, but it is not true that all firms are just similar, neutral **"dots"** acting in a world of supply and demand curves. And as this is not a useful or relevant description of the world in this connection as it also leads to the wrong conclusion.

In this paper, Section 5.4, it is argued that when one regards firms as organisms, which are very differentiated, it is no longer inconsequential which firms and groups one selects as the carriers of innovation and green technology. It is also obvious, that the fossil fuel companies will be the firms with the least motivation to introduce technological solutions, which decrease the consumption of fossil fuel. Consequently, it is not a good idea to place the innovation responsibility and the funds -via free CO2 quota gifts- in the hands of the fossil fuel companies, as it is envisaged in the CO2 quota and "tradeable permit" construction, where the largest polluters are given the largest pollution present as a starter gift.

It is necessary, as we try to do it here, to regard firms as organisms, which have different types of organisational inertia and different economic motivation structures. With regard to fossil fuel and uranium based companies, the ground for renewable energy and energy conservation innovation is quite barren. Consequently, a system of tradable quotas, which transforms the past CO2 emission levels into CO2 quotas, as public presents to the historically largest polluters, is a way of transferring the "innovation funds" to the most resistant and most expensive "innovators", within renewable energy and energy conservation innovation activities. Therefore, it is important to establish

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public regulation measures that channel the seeds and funds for innovation to independent and dynamic newcomer companies and groups outside the range of fossil fuel and uranium companies.

10.5 Conclusion regarding the 1999 electricity reform and its goal performance

In Section 9.1.4 we summarised the performance of the Danish electricity supply system, and its second order governance system in Table 14. We also developed an array of proposals in order to improve the system where it was performing badly. In this section we will evaluate to what extent the 1999 electricity reform solved the "before the reform" performance problems of the, at that time comparatively highly well functioning Danish electricity system.

The conclusions regarding efficiency in relation to the energy policy goals of Figure 6, related to electricity production are:

Generally speaking, the success of the current "liberalization" model is up against very heavy odds, and one should expect rather low efficiency with regard to achieving these goals.

a. The difficulties are, amongst others, caused by the following base conditions: firstly, only around 10% of the added value within electricity production comes from the "liberalized" part of the power plant sector, which is the only part of the value-added chain being liberalized. Secondly, even liberalizing the power plant sector is difficult and will result in considerable regulator transaction costs, due to the capital structure of power production with heavy investments, the 30 year lifetime of plants, and the fact that present typical electricity systems have only around 40% of total long-run marginal costs as short-run marginal costs. Thus, the outcome of competition easily becomes a situation where it is not possible to cover the capital costs of investments, which is unacceptable for the actors. Consequently, there will be a very strong drive towards merging and the establishing of "strategic alliances"[74]. This tendency has proven to be almost the mainstream development after the introduction of "liberalization" reforms. The result has been and still is a very low "price efficiency" as in, for instance, the UK and California liberalization experiences.

b. Any "liberalization" reform has to be compared with the goal perfor-

[74] An "Orwellian" coinage which, in many ways, is applicable to the same activities as cartellisation previously.

mance of the concrete regulation regime, which it replaces. It is obvious, that even a badly functioning liberalization process, with the inherent difficulties discussed above, might be better than the regulation system it replaces. Here we have compared it with the Danish "liberalization" model with its non-profit/consumer-profit organisation and the public regulation regime, which was in existence until the electricity reform in 1999. The result of this investigation is the following: firstly, the hitherto Danish regulation model has had the lowest electricity prices in the EU for industries with consumption below 1 mil. KWh/year, which is a typical consumption, level within the Danish industrial structure with its many relatively small companies. Secondly, there **is a** built-in cost sensitivity in the consumer owned Danish systems:

- The consumer-elected representatives will replace incompetent directors, if the company is doing badly.
- There is no motivation for price increase due to shareholder requirements, as there are no shareholders in a consumer owned company.
- There is consumer cost control at the transmission and distribution level through the representative system. In the market model with shareholder ownership, such consumer cost control at the transmission and distribution level will be non-existent.
- The prices at power plant level will be set according to average costs of power plant production, and not according to the marginal costs of the most expensive power plant producing.

Altogether one can say:

If the core of liberalization is increased consumer influence upon costs and prices, the present "liberalization" and "shareholder privatisation" model does not represent any liberalization increase. The contrary seems to be the case. As there is no increased consumer power in the present "liberalization" and "shareholder privatisation" models, it is not surprising that the 1999 "liberalization reforms" will not bring price- or even long-term cost decreases in the Danish electricity service supply system. The opposite is rather the case.

The introduction of "market models" for renewable energy

In the Danish case a double market system should be introduced around 2003. It is not yet totally clear how it is supposed to work, and there is a widespread scepticism as to whether it will at all function competitively. So far its results have been that, at present, no new windmill contracts are undersigned, due to the insecurity about the design of the future regulation regime.

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There are several problems linked to the new model:

- The introduction of a Nordpool and Leipzig market oriented price for renewable energy sold to the public grid instead of the present fixed price based upon the long-run marginal cost principle is a step backwards. This is because in periods with excess capacity, as is currently the case, it replaces a system based on a “secure” long-run marginal cost price, with a price which oscillates around the short-run marginal costs of existing power plants. Probably five to six years ahead, there will be excess capacity in Northern Europe, with short-run marginal cost pricing at the markets hindering the introduction of any new technology, even if it has lower total costs than coal and/or uranium based power production.
- The introduction of a “Political amount-/certificate price market" system will cause very fluctuating prices for CO2 payment. Although CO2 costs are difficult to assess, we know that once assessed, there is no reason to believe, that they would not fluctuate by a 2.7 factor within a month or year, as the CO2 payment is allowed to do in the future Danish “Political amount-/certificate price market" system. It is a wrong price mechanism seen in relation to any external cost reality, and it introduces insecurity to such a degree, that the large independent investor groups, which have so far carried and supported renewable energy, will have to cease investing. Only the energy companies with their lack of organisational motivation, and investor companies, who have so far had no serious interest in renewable energy, will remain on the market. This might result in increased prices for renewable energy based electricity and /or decreased expansion.
- The motivation for minimising renewable energy production costs might decrease, as, in a politically set quota system, producers no longer have the possibility of increasing their sales by lowering prices. The hitherto decline in production costs might stop and be replaced by “strategic collaboration” between, for instance, wind generator producers.
- Furthermore, it is worth mentioning, that the new system with fixed quotas and variable prices is by no means (or definition) more “liberalization-” or “market-” oriented, than a system with fixed prices, and variable amounts. In fact, cost reduction potential might, as mentioned above, be stronger in a system which rewards competition between, for example, wind generator producers, by increasing market size, when they decrease production costs and sale prices.
- The new “double market” system does not foster possibilities of improving the system efficiency of the electricity system by establishing dynamic prices, thus encouraging the regional use of fluctuating renewable energy sources.

In Table 21, the conclusion is summarised. It enables us to ascertain that the numerous problems stated above have arisen because of the 1999 reform. Thus, we can conclude that even as far as the “liberalization” core goals, that is cost and price efficiency, the performance of the “liberalization” version is poorer than the consumer ownership system. In the Table, the darker the areas are, the worse the performance is. If we take “price efficiency”, the table was white (indicating good performance) before the 1999 reform, and becomes dark grey after the liberalization reform (indicating bad performance). One + indicates a problem, more crosses indicate more problems.

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Goals	Remaining problems before 1999 reform	Result of 1999 "Liberalization" reform	Remaining problems after 1999 reform
(1) Supply security	None	Cost competition and dismissing employees especially at power plant level	Decreased supply security due to less maintenance.
(2) Price eff.	None	Power plants can be sold, and probably will enter the North European oligopolistic power structure. Motivation for price increases, where possible.	Decreased price efficiency with regard to: both price level and price distribution.
(3) Cost eff.	The ministry of energy is still not able to ensure that excess capacity is not built. +	Power plant motivation for cost efficiency linked to the development of share value.	A change from profit maximisation with a long-term horizon to maximisation linked to shareholder value, therefore with a short-term horizon. ++
(4) Conservation eff.	The tariffs are still supporting consumption increase. Capital in supply system is too cheap.+++	From a "one man one vote" + non-profit price mechanism to "market power" + shareholder profit based price mechanism at power plant level.	Shareholder profit oriented prices with high prices for small consumers and high fixed prices and relatively low running prices. ++++
(5)Innovation eff.	Still belated inclusion of independent groups. Not sufficiently proactive. +	Prices for renewable energy will oscillate heavily. Decrease of investment opportunities for neighbours and independent investors.	Decreased innovation efficiency due to market prices, which oscillate, and are currently ***close to the short-term marginal*** costs of large coal plants. ++
(6)System eff.	No system regulation of windpower, cogeneration or consumption ++	No measures are introduced. The system responsibility monopoly is given to the existing firms closely related to fossil fuel companies.	No utilisation of the new regulation potential built into market price regulation. The establishment of a price system with "local markets" has not been introduced.++
(7)Democratic eff.	Still problems both within the electricity system and within the public regulation processes ++.	No real improvements of democracy within the electricity companies. Now a coming shareholder governance system.	No improvements with regard to establishment of a democratic liberalization process. Some deterioration of democracy at the power plant level.+++
(8)Competitive efficiency	Still a problem with no free capital. +	Subsidies, amounting to 7 billion DKr, to the large coal-fired power in order to make them competitive.	The problem has changed. Now the power plants could accumulate "free" capital. But due to the current low prices, they cannot.+

Table 21. Changes in goal efficiency of the Danish electricity service supply system caused by the 1999 electricity reform

As Table 21 illustrates, the 1999 electricity reform does not solve any "before reform" problems, but rather adds a set of new problems, especially linked to the new organisation at power plant level, where the power plants might be partly sold to external competitors.

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11.Conclusion/executive summary

11.1. Analytical macro-structure and the main questions in this study

In Figure 40 the analytical macro-structure is repeated from Figure 1 in the introduction.

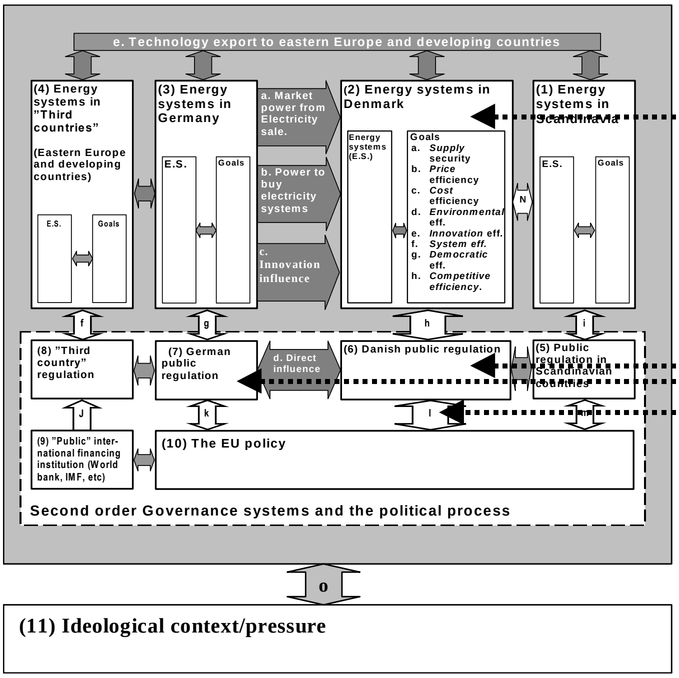

Figure 40. The analytical macro-structure

In this book we have dealt mainly with a description of the Danish electricity system, box 2, the Danish public regulation, box 6 including a description of some links to the EU policy, box 10, the German public regulation (the areas shown by the dotted arrows in figure 40). The energy system in Germany,

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box 3, has been analysed in (Mez and Piening 2001), and a case of "ideological context/pressure", and the link between German and Danish public regulation, has been discussed in the book "Renewable energy governance systems" (Hvelplund 2001).

It is worthwhile to mention that the above analytical macro-structure contains areas, which have not been dealt with in this study. For instance we have only looked at some aspects of the development in the Scandinavian electricity market. And an important limitation is that this study does not include any description or analysis of the interrelationship between the electricity systems in Northern Europe and Eastern Europe and the developing countries. This limitation should be mentioned, as the large market for new uranium and fossil fuel capacity is in Eastern Europe and the developing countries. So dealing with electricity reforms, democracy and technological change also needs thorough studies with regard to energy technology transfer from the industrialised countries to Eastern Europe and the developing countries. This field of study is interesting and important, but has been outside the scope of this study.

The purpose of this study has been to analyse the following four questions:

1. Which governance systems are most efficient, with regard to achieving optimal goal performance by means of the present typical uranium/fossil fuel electricity supply systems?

2. Which governance systems are the most efficient in the transformation process from the present uranium/fossil fuel electricity supply systems to renewable energy-/conservation based electricity system?

3. Which changes in goal performance of the Danish electricity supply system has the 1999 Danish electricity "liberalization" reform induced?

4. Will the Danish electricity supply system be able to maintain its consumer ownership institutions and remain independent of the "third party" shareholder ownership structure after the 1999 Danish "liberalization" reform?

11.2 Governance systems and goal performance of typical uranium/fossil fuel based electricity systems.

It is important to "follow the money" and describe electricity systems by their value-added distribution, which can tell a lot about the concrete economical conditions of organisations linked to different types electricity production technologies.

It is also important to escape the present dichotomy; *market versus public regulation* and establish a broader governance study by focussing on four levels, *public regulation, market regulation, ownership regulation and communicative regulation*.

11.2.1. Value-added distribution and governance systems

Governance systems: Consumer power via market, state, ownership and communication

Figure 41 shows the essence/goal of liberalization, which here is regarded as an establishment of optimal consumer control over the electricity supply system in order to achieve cost and price efficient electricity services. This control can be achieved via Parliament/public regulation, the marketplace and consumer ownership. Whether this control function is dependent on how the communication functions in the public space. The result of the analysis in this book is that all four levels need to be well functioning if the consumer power should be able to exert sufficient control over the electricity supply system.

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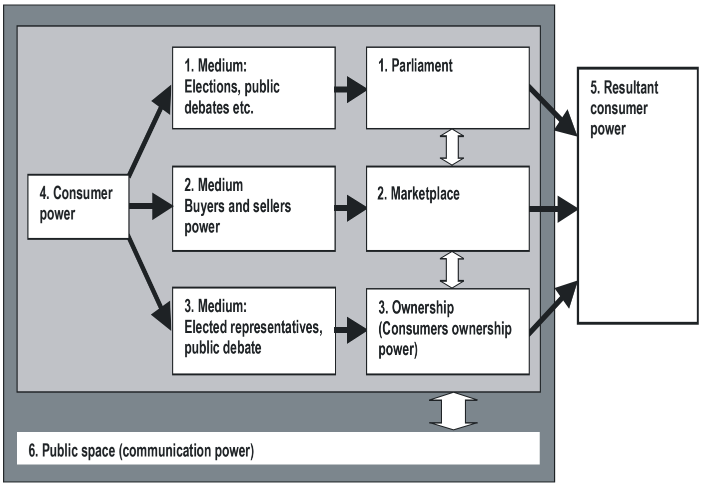

Figure 41. Economical and political liberalization, and the "four-line" consumer regulation

Uranium and fossil fuel value-added system.
A typical uranium-/fossil fuel electricity supply system is characterised by the Figure 42, value-added distribution

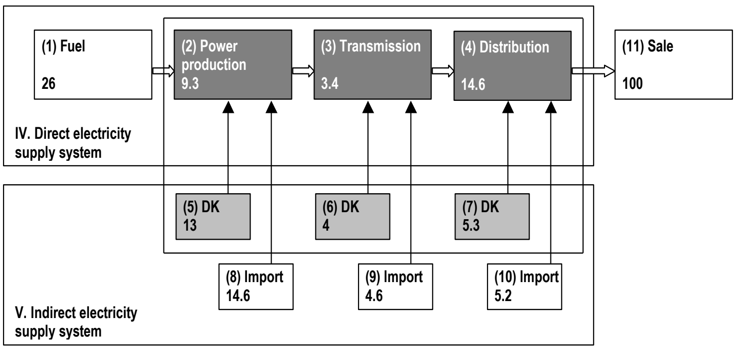

Figure 42. Value-added distribution in a Danish coal based electricity supply system

When selling electricity at the consumer level for 100 DKr., only 27.3 DKr. is produced in the Danish electricity supply system shown by the dark grey boxes 2,3 and 4. The rest is produced in the fuel proliferation, box 1 26 DKr, and in the equipment production sectors, boxes 5,6,7,8,9,10. A nuclear system would look rather similar, with a slightly lower fuel share. The German system is characterised by ownership integration of the fuel proliferation system with the electricity system, and with some ownership integration of electricity supplies system and equipment production. The German electricity supply system thus differs from the Danish electricity supply system by organising under the same ownership structure between 50% and 70% of the total value-added in electricity production. The political behaviour of electricity systems naturally is dependent upon their value-added structure. The coal miners have substantial influence upon the German power system, but no influence upon the Danish power system[75].

Conclusion 1. The present *asymmetric* " market liberalization" is an illusion and will not work.

The present "liberalization" model is an *asymmetric* "market liberalization" model. Asymmetric because it only tries to establish consumer influence through buying power at the market, but does not deal with the necessary democratisation of the political regulation needed to control the monopoly parts of the value-added chain. This asymmetry is fatal, when dealing with systems, where up to two third of the value-added is produced in grid companies, which remains technical monopolies, and where the rest is produced in power companies with a very strong economical "merger" motivation[76]. Experiences from “liberalization” in the real world are beginning to unveil the considerable shortcomings of the present liberalization models. This is the case, for instance, in California, New Zealand, Denmark, and the UK.

It looks as if the legislators and their economic advisors have forgotten to look closely at the value-added chain and the cost structure of present electricity systems, the situation of change and the capture problems, as well as transaction costs needed to control a system with such characteristics. The telescope seems to be placed in front of the blind eye, and many supporters of the present *asymmetric* "market liberalization" version apparently have

[75] We experienced this fact, when we in 1993 presented an alternative energy plan which phased out lignite, "Erneuerung der Energiesysteme in den neuen Bundesländern-aber wie?", Hvelplund, F,Knudsen N.W, Lund,H.,in Cottbus. The lignite miners were demonstrating outside the house, where the plan was presented.

[76] Due to investment risks caused by asset specificity, capital intensity and the long plant lifetime.

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forgotten that distribution- and transmission services will remain technical monopolies in classical electricity systems.

Figure 42 illustrates what the problems in the *asymmetric* "market liberalization" illusion is all about. Looking at the value-added distribution, "liberalization" of an electricity supply system of the Danish type will not influence fuel proliferation or equipment production. It basically only deals with the 27.3% of the value added which is produced within the production, transmission and distribution parts of the whole value-added chain. When looking at these 27.3%, it is clear, that neither distribution- nor transmission grid services can be liberalized, as there will only be one distribution network and one transmission grid system. What remains as a possible market "liberalization" goal is the value-added at the power plant level, or in this case 9.3% of the total electricity price at the consumer level.

It naturally might be possible to decrease the costs at the power plants_by dismissing some people, as this has happened and will continue in the future. But the power plant business is, due to the cost structure with high long-run marginal costs and relatively low short-run marginal costs, in combination with a lifetime of 30-40 years, a very risky business. This business cannot survive a competition with many mutually independent power producers, as this might result in a market price close to the short run marginal costs, and consequently no amortisation of capital costs. Consequently, they will have to enter into "strategic alliances[77]"- and merger arrangements. This exactly is what is going on in these years in Northern Europe and -by the way- all over the world.

So -in the end- and this is the main message here, it is not possible to foster an efficient “liberalization" and “privatisation” process of the electricity system *if one only goes half the way*, and does not include a systematic democratisation or "political liberalization" of electricity supply systems.

Conclusion 2. There is a need for *symmetric* liberalization by adding consumer ownership to the governance system.

In Denmark and in all other countries, distribution as well as transmission systems remain monopolies. In Denmark, as mentioned, they represent 65% of the added value in the electricity supply system.

If we regard liberalization as increased consumer power, which can be achieved through the four channels shown in Figure 41, consumer ownership is logically “the only” way of liberalizing the monopoly part of the value-

[77] The modern "management style" Orwellian word for cartels.

added chain, namely distribution- and transmission networks. Here we call the consumers the "first party"; the workers at the electricity sector the "second party" and groups outside the producer consumer relationship the " third party". With this vocabulary in mind, it is worth emphasising that consumer ownership is a "first party" privatisation, whereas shareholder privatisation is "third party" privatisation.

It should here be emphasised that "shareholder" privatisation of the technical monopoly activities linked to transmission and distribution will need a very tough public price control authority, as there will be a constant shareholder motivation for trying to achieve monopoly profits. Without a policy of extreme openness towards the public regarding costs, prices, and price control and a very active press and public, a capture process, where the electricity companies captures the state regulator is very probable.

Consumer ownership of the technical monopoly parts of the electricity system does not run into these problems, as the profit is always recycled to the consumer. This is one of the causes behind the fact that the Danish electricity system has supplied the lowest electricity prices in EU Europe during the last decades.

Consumer ownership should be introduced in electricity systems with regard to at least the transmission and distribution monopoly sections of the value-added chain of electricity systems. An EU directive requiring this reform could be the content in the next new EU "liberalization" version, including democratisation and political liberalization.

Conclusion 3. There is a need for political liberalization through increased administrative openness and empowerment of the public.
For instance, concerning the power plants, there is a need for very strong public regulation of price policy. This might result in a capture process, where the ones who should be regulated command the regulators. Consequently it is a must, that the state regulation body has a policy of total openness with regard to cost and price information. Such a policy is, by the way, truly in line with the theoretical base of liberalization, demanding full transparency, and in that way, enabling the consumers to buy the best and cheapest products.

It should be emphasised that public regulation is not the same as State regulation performed by high-ranking employees from the Ministries. Efficient public regulation requires both democratic processes with openness of information, and financially empowerment of independent consumer groups.

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In this way, such groups are enabled to buy consultancy support, and perform an efficient control of the "state regulator".

11.3 Which governance systems are the most efficient in the technological transformation process?

(From the present uranium/fossil fuel electricity supply systems to renewable energy-/conservation based electricity system)

Figure 43 illustrates the change in value- added, when going from traditional uranium-/fossil fuel electricity supply systems to renewable energy-/energy conservation systems.

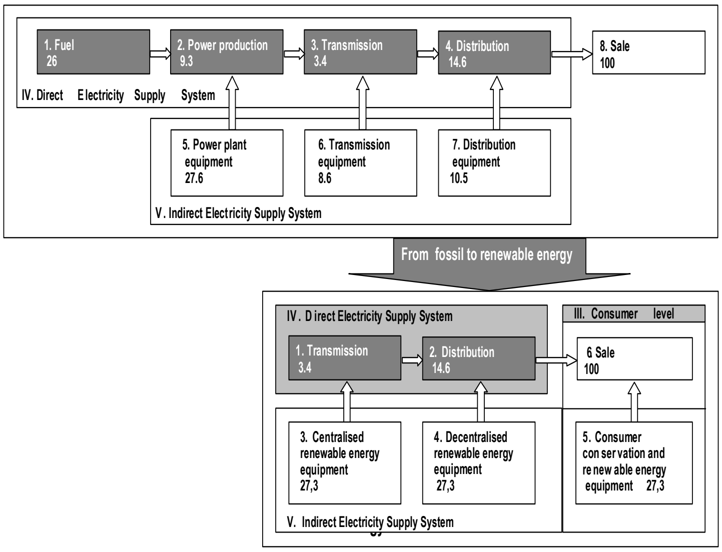

Figure 43. Value-added and the transformation from uranium-/fossil fuel systems to renewable energy-/conservation systems

The figure illustrates two important conclusions:

a. The transition entails a substantial decrease in value added in the traditional electricity supply companies. This also brings along a decrease in the profit of these firms.
b. Fuel proliferation as well as the value added at the power plant level dis-

appears from the traditional electricity sector. As the power plants **become energy automatons**, the value added is produced at the equipment factory, and the maintenance often carried out by these factories.

Consequently the traditional electricity producers will lose value added and profit in this transition process, and therefore work against this process.

Conclusion 4. As the traditional electricity supply systems are losing value added in a transition to renewable energy and energy conservation, they have worked, and still are economically "forced" to work politically against this process.

Building on Conclusion 4, we can develop the next conclusion.

Conclusion 5. It is important to establish public regulation policies that empower investor groups that are economically and politically independent of uranium and fossil fuel interests.

As the transition represents a development towards energy automatons, where an increasing part of the value-added is allocated at the equipment producers, the following conclusion can be stated.

Conclusion 6. In the future energy systems the equipment market is increasing its importance, and the market for electricity is dwindling. Therefore, it is of great importance to establish a very competitive equipment market. The Danish "political amount-/certificate price market" system for renewable energy therefore is a historic mistake, as it weakens the competition at the increasing market for equipment, and establishes a "price market" at the dwindling market for electricity.

As renewable energy- and conservation technologies have different natural resources/conditions from region to region, a common European renewable energy certificate market will result in a mono-price system, where, for instance, wind turbines at the best sites will get the price which is necessary for wind turbines at inland sites. This will result in an overly expensive renewable energy development.

A renewable energy certificate market for Europe is an institutional construction designed to fossil fuel systems, where there is one world market price for fuels, and the accessibility of the "resource" therefore equal for competing companies all over Europe.

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Conclusion 7. Natural resources vary from region to region; a European renewable energy governance system should be regionally flexible and be based on the principle of site efficiency.

Regarding the introduction of amount quotas and a market for "Green certificates".
This system can be called a "Political amount-/certificate price market" system, where the amount is politically set, and the price is developed at a certificate market.

The competing system, which is being used, for instance, in Spain, Germany and France, is a "political price-/amount market" system, where the price is politically set, and the amount of renewable energy decided upon a market.

Interestingly enough the "Political amount---" model has succeeded in becoming "THE" market model, whereas "The political price--" is considered by for instance the Danish energy administration to be a "non market" model. Basically it is not possible to call any of the two models "more market oriented" than the other.

There are many problems linked especially to the "Political amount---" model, as it will end up with only two large renewable energy sellers and around three to five large buyers at the market. In reality, the market cannot function with sufficient competition with so few actors/competitors.

Furthermore, the very fluctuating prices will result in heavy difficulties for individuals, when they want to borrow money for investment in renewable energy. The investor groups will be the large power companies and potentially large pension funds. Renewable energy, and especially wind power, will become unpopular, as people may not like wind turbines in their neighbourhood unless they get some kind of profit or compensation.

Conclusion 8. A "Political price-/market amount" system should be introduced at a European level. In connection to this it is very important to establish a system furthering neighbour- and local ownership.

Without establishing a system where the ones having to hear and see the wind turbines in their neighbourhood are compensated by having ownership shares, local resistance will easily become politically insurmountable.

Regarding CO_2 quotas and tradable permits
The main problem here is that the CO_2 quota and a system with tradable

permits are giving the economic "carrot" to the "fattest horse". By this it is meant that giving a pollution quota to the actors (often for free), which, until now, have had a given CO2 emission, is also a way of giving the incitements for green technologies to the old fossil fuel companies. But these companies have the least motivation for investing in new green technologies, as they are economically, and with regard to know-how, embedded in a system of fossil fuel technology "sunk costs". When a fossil fuel company has a coal-fired plant, new technologies will have to compete with the short-run marginal costs within this company. Consequently, motivating investment in a given amount of green technologies will require much higher subsidies and/or payment for tradable permits in fossil fuel based companies than in companies, which are independent of fossil fuel sunk costs.

Conclusion 9. The introduction of a system with a CO2 tax in combination with a system of price- and investment subsidies to new renewable energy technologies is giving the "economic carrot" equally to all potential investors. In that way, the incitement is also given to companies that are totally independent of existing fossil fuel and uranium based energy companies.

With regard to technological innovation processes, it should be acknowledged that radical technological changes do not come from old, strong actors on the energy scene.

Conclusion 10. The Government should always try, with both financial resources and established independent information networks, to obtain a strong and well-articulated “second opinion” on development possibilities. Such a system, which, to some extent, is established in Denmark with a network of publicly supported energy offices, supplies the Government with new policy options, and makes it easier for politicians to make a choice, as they will have a number of differentiated and qualified solutions to choose from.

11.4 The 1999 "liberalization" reform and its effects on the goal performance of the Danish electricity supply system.

As shown in Table 22, the Danish electricity supply system has had a very good price performance before the electricity reform. This is the result of the characteristics below.

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Country	Denmark	Finland	Sweden	UK	France	Belgium	Germany
(2) Payment in DKK 160.000 kWh/year consumer	59200	66400	75520	104000	100800	141120	148960
Payment, øre/kWh	**37**	**41,5**	**47,2**	**65**	**63**	**88,2**	**93,1**

Table 22. 1997 electricity prices per kWh excluding taxes in some EU countries
Source: Statistic in Focus no. 28, Eurostat 1997.

1. A system of consumer profit and consumer ownership system. This means that the consumers have ownership control with the distribution and transmission technical monopolies as well as with the power plants.
2. A system of almost total openness of prices and costs.
3. Cost reductions are transferred to the consumers as lower prices. Therefore, the consumer representatives have an interest in low prices.
4. As there is no "third party" ownership, there is no interest in higher prices to any "third party".
5. Although having area monopoly, the directors and employees of distribution companies are competing against each other because of the price and cost openness. A director will get fired if his distribution company shows results that are not living up to the standard published in the annual price statistics.

All together, the Danish consumer profit and consumer owned system is close to being one of the only really ***symmetrically*** liberalized and privatised systems in the world, if consumer control is to be regarded as one of the fundamental features of a liberalized system. *The consumers can maximise their utility at a market, where competition between different mutually independent producers is possible. But where there is a technical monopoly, as when dealing with distribution and transmission grid systems, the consumers can only maximise their utility function by means of well functioning political channels of influence.* The result of the Danish consumer profit and consumer owned system indicates that this system has had, and still has some qualities that - although not at all perfect - can compete very efficiently with the state control governance of grid and transmission systems in the so-called "liberalized ", but in reality asymmetrically only "market liberalized" electricity systems.

Conclusion 11. A well functioning consumer profit and consumer ownership electricity supply system represent a *symmetric liberalization*, where both buying power at the market, and political power in the decision processes are liberalized. It therefore is close to the ideal symmetric governance model, which is needed, when dealing with electricity systems with their high value-added percentages within companies with technical monopoly.

Furthermore, it should be mentioned that when dealing with power plants, with their very long lifetime and capital intensive cost structure, consumer ownership is a way of securing that some power plants are independent of the large North European power company families.

The 1999 electricity reform has not improved the goal performance of the Danish electricity supply system. The goal performance of the system can be expected to decrease, especially because of the risk of selling the power plants to some of the surrounding electricity supply conglomerates.

11.5 The 1999 "liberalization" reform, internationalisation and the ownership structure of the Danish electricity supply system

In chapter 10 we concluded, that the 1999 electricity did not improve the goal performance of the Danish electricity system. In chapter 1 we asked the following questions:

a. Are the Danish power companies able to compete on the Danish electricity market with foreign companies?
b. Will the Danish energy companies be able to compete on the market for energy capital goods, or will foreign companies, for instance German power companies, buy them? Will the Danish consumer ownership model survive?
c. Will the Danish "flat" price structure survive on the future electricity market?
d. Will the 1975-2000 energy technology innovation process survive under the new market conditions? How will conditions on the German market influence this development?

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Are the Danish power companies able to compete on the Danish electricity market with foreign companies?

Nothing indicates that the production costs at the Danish coal-fired power plants are higher than at coal-fired power plants elsewhere in Northern Europe. But periods with excess capacity in 1999 and 2000 brought the electricity price down on the short-run marginal costs of coal-fired plants. Although the Danish power companies could be regarded as very well consolidated, the very low price did not allow for paying amortisation costs on capital equipment. Hence the government entered an agreement with the power companies, giving them economic security against prices at the 1999 and 2000 level. The distribution monopoly companies should pay this security payment.

Conclusion 12. The Danish fossil fuel power companies could not, although having a very low debt, compete on so-called market conditions at the Scandinavian Nordpool market. Public financial support was necessary.

Will the Danish energy companies be able to compete on the market for energy capital goods, or will foreign companies buy the Danish electricity infrastructure?

Whether someone would buy parts of the Danish electricity infrastructure depends upon the profit possibilities of the potential buyers as well as the potential sellers. The distribution and transmission monopoly companies are basically non-profit companies, with relatively thorough and bureaucratic price control. Furthermore, the 1999 electricity law requires at least 50% consumer influence in the distribution monopolies. Regarding the system operator, which owns the transmission lines, the state has pre-emptive right in case of sale.

Conclusion 13. With the present rules, it is not probable that those foreign investors will buy the transmission- and or the distribution monopolies. They seem to be rather well grounded, as consumer owned monopolies.

Regarding the power plants, they are now allowed to earn a profit, and might be interesting partners for other power companies around Denmark. So far they have not been really interesting investment objects, as the price on electricity on the Nordpool market has been close to the fuel cost linked to electricity production. The Danish power companies, nevertheless, are interesting partners in the ongoing process of establishing market control and higher and more stable prices.

Conclusion 14. There is a latent external interest (E.ON Energy, Vattenfall, etc.) in buying the Danish power plants. A scenario, where the Danish power plants are becoming partners in the oligopolistic power plant structure around Denmark is probable.

Will the Danish "flat" price structure survive on the future electricity market?

The monopoly parts, transmission and distribution will probably remain consumer owned companies. It is difficult to localise any motivation indicating that these companies should change their "flat price" policy. So regarding the transmission and distribution activities, which accounts for more than 60% of the value added in the electricity companies, the motivation for a "flat price" structure remains. Regarding the power market, there is a possibility that larger firms can use their buying power to get better offers at the market. This will indicate an increase in the price spread at the power market, seen in relation to the policy until the 1999 reform.

Conclusion 15. In general, the future "price spread" will increase, but still, due to the consumer ownership of transmission and distribution activities, will not reach the level of price spread in our neighbour countries.

Will the Danish 1975-2000 energy technology innovation process survive under the new market conditions?

The Danish authorities have, through the 1999 introduction of the "Political quota-/certificate price market reform”, stopped the implementation of renewable energy in Denmark for a while. At present, almost no new wind power contracts are signed in Denmark. Nothing really indicates that this situation will improve for the coming months, as the Danish administration still does not seem to be willing to leave the "Political quota-/certificate price market" model.

The influence from the German, Spanish and French "Political price-/market amount " system might convince the Danish politicians that they should leave the "Political quota-/certificate price market" system. In 2001, the Danish wind power industry survives because of sales to the markets in countries, like Spain and Germany, which did not apply the Danish "Political quota-/certificate price market" system. Therefore, it can be seen that the “Political quota-/certificate price market" system may not be the best model for Denmark, but at present, the situation is still in a political deadlock.

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